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JANUARY 7, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

JAN 1963
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First Photo of Mauler Mockup

JPL's Planetary Role May Be Trimmed . . . 14
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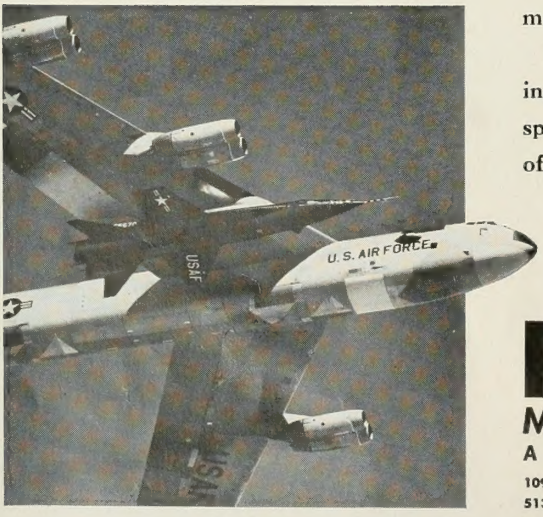


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Television eye under the sea

Bell System experiments with ingenious TV vehicle to rove ocean floor and inspect vital undersea cables —another way the Bell System seeks to assure high reliability of military and civilian communications.

Undersea cables provide important paths for military and civilian communications.

But, until recently, it was impossible to view these cables on the ocean floor and examine their condition.

Now this may be changed.

In a recent experiment, Bell System scientists viewed submerged cable via an unusual underwater TV vehicle.

From a surface ship, the vehicle was driven to the ocean floor and located cable via the TV camera. By remote control, the vehicle was maneuvered along the cable's path.

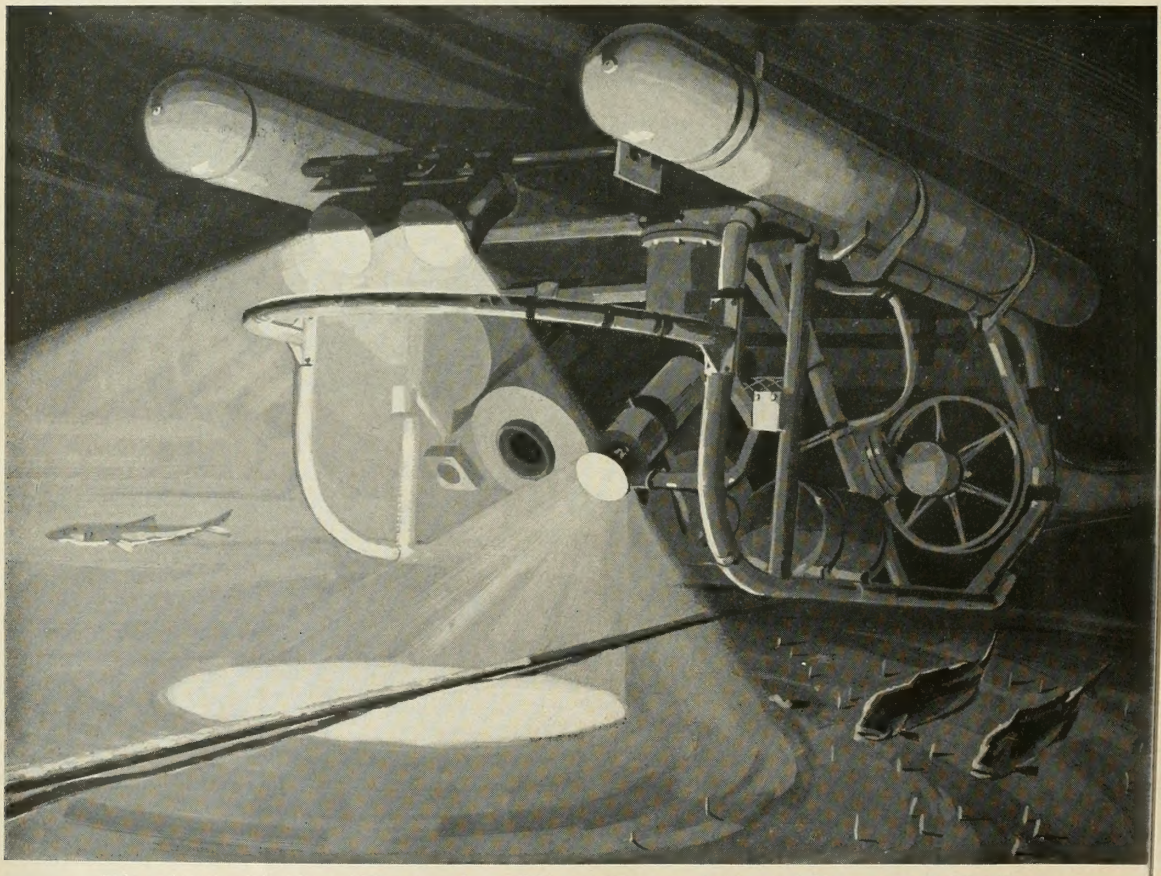
This was the first systematic study ever made of undersea cables.

And by it, the Bell System learned many things that will result in improved designs to meet ocean bottom conditions and permit further advances in cable laying techniques.

The underwater television vehicle is another illustration of how Bell System ingenuity is constantly at work to assure round-the-clock reliability of military and civilian communications.

Bell Telephone System

AMERICAN TEL. & TEL. CO. / WESTERN ELECTRIC CO. / BELL TELEPHONE LABORATORIES / 21 OPERATING COMPANIES



This underwater television vehicle uses a boom light and TV camera to inspect cable as deep as 250 fathoms. The vehicle is self-propelled, guided by remote control from a surface ship. Originally designed by Vare Industries for other uses, the vehicle was modified and adapted by Bell System engineers for cable observation.

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 1 January 7, 1963

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THE COVER



First photo of engineering mockup of fire unit for Army's General Dynamics/ Pomona Mauler air-defense missile. Operator-crewmen load missile, in shipping container, onto firing unit.

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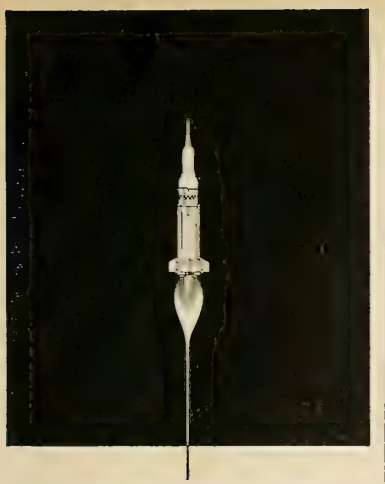
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letters

Transfer Complexities

To the Editor:

Here are a few remarks I wish to make as to your fine report concerning our studies of Manned Planetary Exploration (M/R, Nov. 26, pp. 79-83).

There is a slight mixup in your description of the EMPIRE contracts—the task descriptions for GD/A and LMSC should be exchanged.

The question of favorable and unfavorable launch time needs some elaboration. There are two different aspects involved. To launch for Mars there is approximately one favorable launch position every two years. But, comparing all the favorable launch positions over a long time (say a decade), it is found that some of the favorable positions are better and some are worse than the average. This has to do with where in its eccentric orbit Mars is during its encounter with our vehicle.

As to the "best trajectories" (meaning minimum energy transfer), this is a somewhat involved question. I think it is best to describe a few examples. We shall look into the problem of minimum energy transfer between a circular orbit C and and a cofocal, coplanar, elliptic orbit E which is completely outside of the circular orbit. The pericenter of E will be referred to as P, the apocenter as A. Now to the example:

Case 1: No celestial bodies move in both C and E. The minimum energy transfer from C to E is, under some restrictions, given by a cotangential elliptic trajectory between C and A. This case has been mentioned on page 83.

Case 2: Very heavy celestial bodies in both C and E; rocket impulses will be used at both terminals. The difference between a cotangential connection along C and A or C and P becomes negligible.

Case 3: Very heavy celestial body in C, none in E. The best transfer is the cotangential ellipse between C and A.

Case 4: Very heavy celestial body in E, none in C; rocket impulses will be used at both terminals. The best transfer is the cotangential ellipse between C and P.

Case 5: using aerodynamic braking upon arrival at E, a tangential transfer between C and P is optimum.

Case 6: Fly-by mission from C past E back to C; it makes no difference whether there is a celestial body in C. But we assume that there is only a small mass in E to render perturbations harmless. Two types of fly-by missions have to be discussed:

Case 6a: The energy to enter the trajectory increases if the maximum distance between vehicle and C increases. The Crocco round trip is a typical example. In this case, fly-by at P is the "best" solution.

Case 6b: The trajectory reaches outside of the apocenter distance of E anyway. The low-energy, two-year, Mars fly-by mission is of this kind. In this case, it makes no difference where along E the encounter occurs.

In these eight examples we found cases in which it is best (in the sense of minimizing speed requirement for impulsive transfers) to go from the circular orbit to the apocenter, in other cases to the pericenter, and in still other cases it makes no difference. This shows the impossibility of generalizing about which constitutes a "good" or "bad" transfer. It depends upon the particular features of the special case being considered.

Harry O. Ruppe
Future Projects Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Channels Re-examined

To the Editor:

Transportation problems for the RIFT vehicle (M/R, Dec. 10, 1962, p. 38) provide a rather intriguing point. Perhaps it is again time to slap wrists of the NASA administrators and politicians who have been too short sighted to see either beyond their noses or farther than campaign issues.

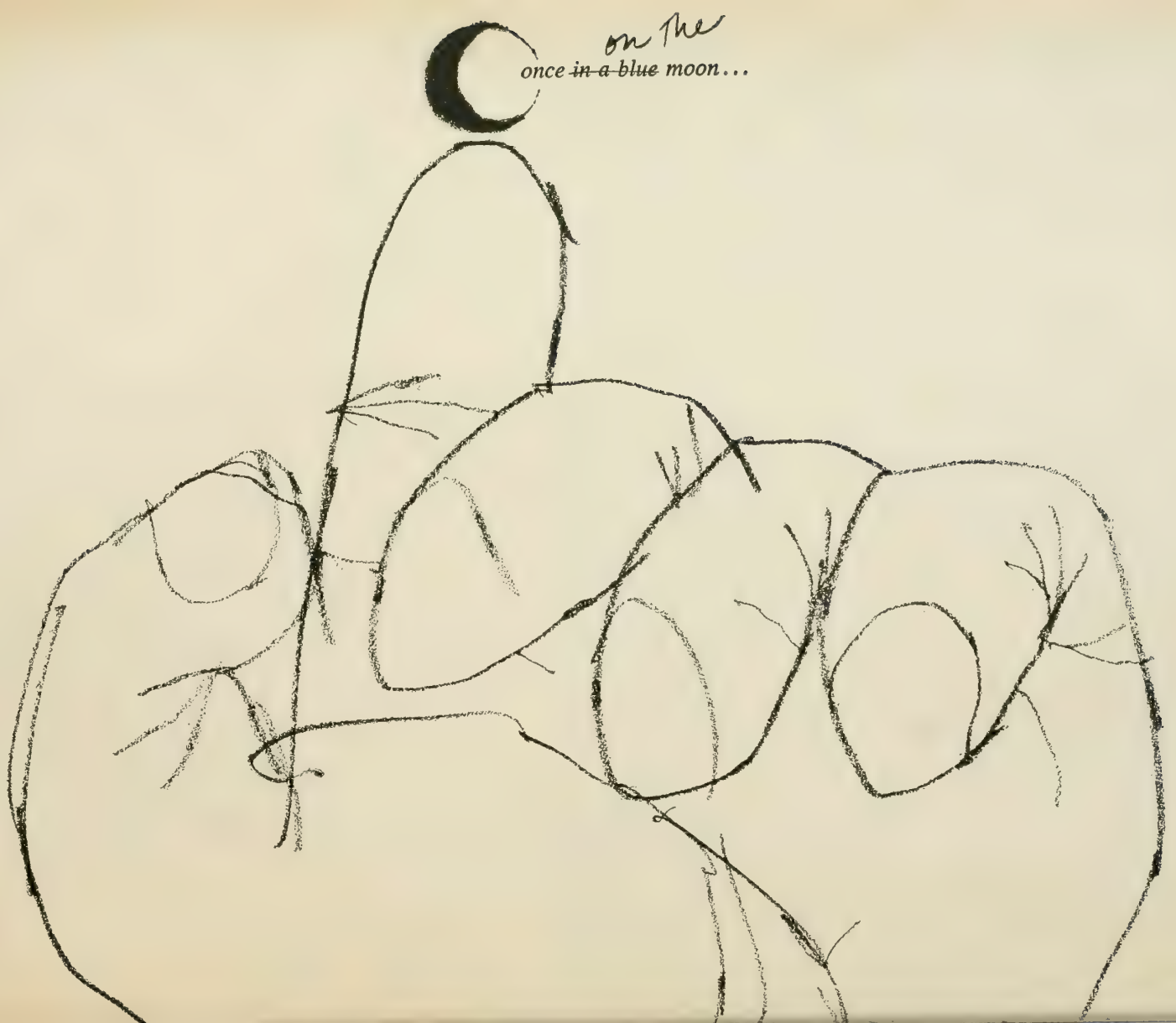
As early as 1948 the highly maligned inventor of the channel propulsion principle for aircraft was able to prove that channels can lift in excess of 14.8#/hp in the static condition. The fact that channels can fly was already known. Since this lifting force is even greater than lifting capability of the helicopter, but without rotor complexity and hazards, it is unfortunate that a cursory NACA study of a prototype channel aircraft never has been re-evaluated with a view toward correcting its own misconceptions.

The most important measurement of NACA RM L53A09 test—static freestream thrust of an unshrouded propeller used in the test—was "guesstimated" by extrapolating a propeller curve into an improbable rotor figure for a six-foot propeller. The remainder of the test was then based upon aerodynamic assumption that all forces must be induced by forward velocity and are effective only in the vertical plane. Many of the testing methods, when reviewed in retrospect, and the data received during the testing indicate that NASA should re-evaluate the powered Lift-plane concept that is usable in all vector directions away from forward motion in the vertical plane. For until this is accomplished there can only be wishful thinking on the part of cognizant engineers and designers who want efficient omnidirectional propulsion for flight.

I would remind you that the rowboat was no better than the mobile powerplant that is putting an outboard in everyone's private budget. A self-contained Lift/Thrust power unit based on channel principle—shall we call it an Elfin unit for the L/F_n derivation?—could be strategically attached to any structure to impart similar augumentation properties for air portation.

Bert Sands
AIRco
Eau Gallie, Fla.

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on the
once ~~in a blue~~ moon...



THE MANAGEMENT OF KNOWLEDGE COMPRESSES TIME AND SPACE

Once on the moon, we can say with certainty that we have taken a long step into space. ✦ Yet the time will come when the moon is a familiar way station. ✦ Centuries have passed while we prepared to take that first substantial step. But the immensely greater steps beyond will only require brief spans of years. ✦ This compression of time is the product of knowledge—its storage, classification, and application. To gather such knowledge, to grasp its significance, to direct its application in new ways to new problems—these are the disciplined activities that accelerate our space program. ✦ The compound of talent and experience that generates such knowledge is present in only a few organizations. ✦ General Dynamics | Astronautics is one of them.

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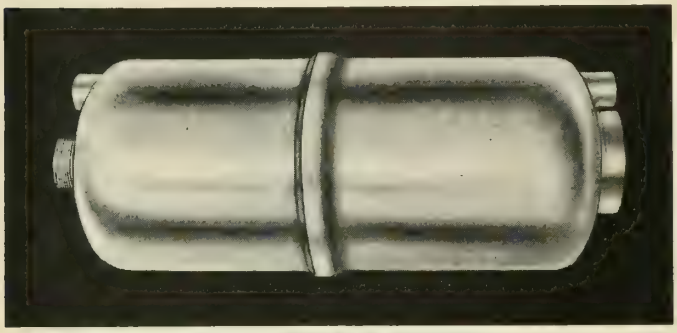
Low Alloy Steel, Shatterproof
Aircraft Pneumatic Reservoir



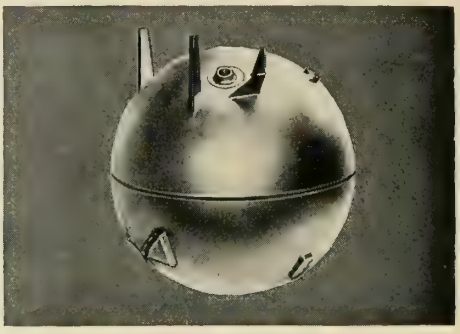
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High Pressure Storage Vessel



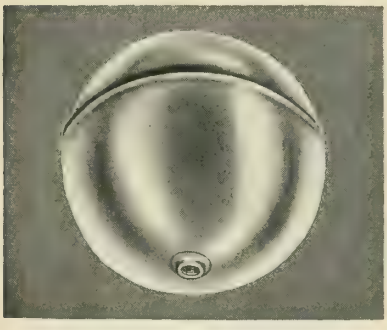
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The Countdown

WASHINGTON

Skybolt Cost Disputed

Only half of the $425 million allotted for *Skybolt* R&D was actually spent, claims British Air Commodore Sir Arthur Harvey, a member of Parliament. Harvey's statement conflicts with the Pentagon statement that R&D costs were $330.1 million as of Dec. 31, and production costs were an additional $23.1 million (see p. 15). The British MP, here to "get the facts" on the cancellation, is also looking into a modified *Skybolt* program to see if it holds any promise of saving the airborne deterrent which Britain has built.

Budgets May Be Levelling Off

White House officials report that DOD's Fiscal 1964 space budget will remain at approximately last year's $1.5 billion level. NASA's budget will be below $6 billion—most officials are talking in terms of a $5.7-$5.9 billion range.

AF Launches First Ion Engine

The Air Force late last month launched the first U.S. ion engine. The ballistic flight was made with a *Scout* launch vehicle from Point Arguello, Calif. A malfunction in the system is reported to have substantially reduced the amount of data obtained.

SNAP Handover Raises Some Hackles

Some NASA scientists are irked at top management for letting the AEC and Air Force take over the SNAP-50 nuclear power system without putting up a fight (see p. 15). Space agency administrators say budget limitations were responsible, but scientists retort that this same lack of funds is also the reason that even current nuclear electric systems are behind schedule.

Down Under Buildup in the Works

The next two or three weeks will bring an announcement of a major expansion of NASA tracking facilities in Australia. Included are plans for a $4.5-million station for the space agency's Deep Space Instrumentation Facility (DSIF). Three other tracking stations also are planned in the same country.

Blackout Investigation Projected

NASA's Office of Advanced Research and Technology is planning a satellite flight series to gain more information about radio blackouts in space. Top management approval is expected, but no time schedule for the program has been established as yet.

Slow Days on the Pad

January and February will be two of the slackest months in NASA's space launch schedule. No shots are slated for this month, and only two—*Syncom* and the *S-66* Polar Ionosphere Beacon—are scheduled next month. Both of these may slip to March.

Ferret Ferreted Out

Newsweek Magazine's breaking of the *Ferret* satellite story finally brings to light one of the principal reasons for Navy's scrapping of its Sugar Grove, W. Va., radio antenna. The Sugar Grove facility was designed to do the job of listening in on Soviet communications via bounce techniques, but was cancelled because of "technological advances." *Ferret* is the advance mentioned, and reportedly does a much better job from orbit with its electronic equipment than the Sugar Grove antenna could have done. Air Force's Arecibo, Puerto Rico, radio antenna has a parallel function and will act as backup to *Ferret*.

INDUSTRY

Aerojet Little Hurt by Skybolt

Aerojet-General, propulsion contractor for the cancelled *Skybolt* ALBM, says it had received about 25% of the funds that were contemplated for the company if the program had gone to completion. It doesn't foresee any significant layoffs, because it had only 340 people working on the program. "As a matter of fact," a spokesman says, "other going programs will be glad to get them." The firm feels there were no big problems with *Skybolt* propulsion, and it achieved some technological advances that can be put to use in other programs.

Laser Considered for LEM Guidance

A laser ranging device may be used as a backup guidance system for the Lunar Excursion Module (LEM) of the *Apollo* spacecraft. It would make range measurements during the lunar landing operation. It's believed the system was proposed to NASA by RCA. Some space agency officials think it would be stretching the state of the art too much; hence a radar backup may yet win out.

INTERNATIONAL

French Cool to Polaris

Reports from France indicate that President de Gaulle won't take up the U.S. offer of *Polaris*. After *Skybolt*, De Gaulle is said to be convinced more than ever that France must have a nuclear deterrent made entirely in France. Conventional armed forces will be cut to pay for it, and conscription will be abolished for the first time since the French Revolution. Some French spokesmen say they'll have a solid-fueled IRBM within two or three years.

Nehru Acquiring Vigilants

The Indian government has asked Britain to include 40-50 *Vigilant* antitank rockets in the arms to be lend-leased by the British as a result of the Red Chinese aggression.

French Start Missile Frigate

Work has begun at the Arsenal of Lorient on a 5500-ton missile frigate with a planned speed of 34 knots—the first such vessel to be built to French Navy specifications. Another ship of the same type will be built at the Arsenal of Brest. Both will be armed with *Masurca* antiaircraft and *Malafon* antisubmarine missiles.



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Symington May Succeed Kerr

Likelihood that Sen. Stuart Symington (D-Mo.) will succeed the late Sen. Robert S. Kerr (D-Okla.) as chairman of the Senate Aeronautical and Space Sciences Committee promises increased acceptance in Congress of Air Force claims to a legitimate space mission.

Symington is a former Secretary of the Air Force.

Though no successor has been named, Symington is the most likely man for the spot, even though he ranks fourth on the committee. Ahead of him in seniority are:

—Sen. Richard Russell (D-Ga.), chairman of the Armed Services Committee, who is certain to turn down the lesser power of the Space Committee chairmanship.

—Sen. Warren Magnuson (D-Wash.), chairman of the Commerce Committee, also considered unlikely to vacate that position for the Space job.

—Sen. Clinton Anderson (D-N.M.), chairman of the Interior Committee, who may pose the only question mark in the line of succession.

According to rules, no senator may be chairman of two committees simultaneously. This is why those ahead of Symington will have to choose between committee chairmanships.

Sen. Anderson is considered the most likely to switch to the Space Committee, but even his moving is thought improbable.

Telstar Design Altered

American Telephone and Telegraph Co.'s *Telstar II,* to be launched this spring from Cape Canaveral, will include some new design changes, though the basic communications package is expected to remain intact.

A modified Douglas *Delta* vehicle —the same type used to launch *Relay* last month—will boost the new satellite into an elliptical orbit of higher apogee than its predecessor.

Thus, it is hoped, *Telstar II* will be lifted above the most intense portions of the inner Van Allen radiation belt.

Bell Telephone Laboratories has been studying various means, in addition to the higher-apogee orbit, to reduce the radiation damage potential for *Telstar II.* Greater shielding, especially for the command circuit, is a distinct possibility, but its employment is not yet positively assured.

As energy levels proved more intense than originally anticipated for *Telstar I,* radiation detectors able to provide data on more extreme energy levels will be used with *Telstar II.*

Telstar II's telemetry beacon will be programed to switch from 135-mc to 4080-mc operation after two years. Ground command then will be able to turn on the device only when it is needed, avoiding continuous broadcast over 135-mc.

Telstar I's communications value ended recently because of radiation damage to the command circuit.

Von Karman Wins Medal

President Kennedy has named Dr. Theodore von Karman the first recipient of the National Medal of Science.

Dr. von Karman is chairman of NATO's Advisory Group for Aeronautical Research and Development (AGARD).

The medal was established by the 86th Congress, for Presidential award to persons who "are deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical or engineering sciences."

The citation of Dr. von Karman reads: "For leadership in the science and engineering basic to aeronautics, for distinguished counsel to the Armed Services, and for promoting international cooperation in science and engineering."

A native of Hungary, the scientist became a U.S. citizen in 1936. He is a former director of Cal Tech, and he headed the Jet Propulsion Laboratory during the war.

Research Survey Available

A comprehensive survey of the nation's basic research programs in the space sciences indicates a strong interest in "telepuppets"—adaptive machines for aid in exploring planets—and radar astronomy where the transmitter is on Earth and the receiver is carried by a space probe.

The 16-chapter study strongly urges making the search for life beyond Earth the top-priority scientific mission of the U.S. space program. The study, moreover, emphatically endorses the present NASA program in the space sciences.

Called "A Review of Space Research," the work is a result of a summer study conducted by contributors under the auspices of the Space Science Board of the National Academy of Sciences at the State University of Iowa, June 17-Aug. 10, 1962. It is available as Publication 1079 from the Academy, 2101 Constitution Ave. N.W., Wash. 25, D.C., $4.00.

Shots of the Week

The Army's *Nike-Zeus* antimissile missile has made its first successful intercept of an ICBM target using decoys.

The successful test was made Dec. 22, 1962, over the Pacific Missile Range.

The Army announcement did not say how many decoys were carried in the *Atlas* ICBM target vehicle launched from Vandenberg AFB, Calif.

A salvo of two *Nike-Zeus* missiles was launched from Kwajalein Is., but one developed trouble and had to be destroyed.

The other went on to complete the electronic intercept. The Army said ground tracking equipment indicated the "target was well within the lethal radius of a *Zeus* operational warhead."

• On Dec. 20, the *X-15* rocket plane made a successful flight from Edwards AFB, Calif., in a test to determine how well it could re-enter the atmosphere without a lower tail.

The 76th flight in the program took the plane to a height of about 32 miles with a top speed of about 3700 miles per hour.

Nova Scotia Gets Nimbus Site

The U.S. and Canada have signed an agreement to build a data-acquisition station for the *Nimbus* meteorological satellite system at Ingomish, Nova Scotia, during 1963.

The agreement involves NASA, the U.S. Department of Commerce, Weather Bureau and the Canadian Department of Transport.

The command and data-acquisition station for the *Nimbus* system, now under development by NASA and the Weather Bureau, is expected to be completed in 1964. It will supplement the station being completed at Fairbanks, Alaska.

NASA study suggests . . .

JPL Faces Mission Curtailment

Goddard, Ames centers eyed as possible developers for Mariner B, Voyager programs

by Hal Taylor

JET PROPULSION LABORATORY may lose some of its responsibility for NASA's lunar and planetary spacecraft projects as a result of a high-level study of the program's management structure.

The chief beneficiaries would be two other space agency installations—the Goddard Space Flight Center, Greenbelt, Md., and Ames Research Center, Moffett Field, Calif.

A spokesman for Goddard confirmed that NASA headquarters has asked the center to study the *Mariner B* and *Voyager* missions. Both programs are designed to explore Mars and Venus in the 1965-70 period.

Another official told MISSILES AND ROCKETS Ames probably will get management responsibility for some of the heavy space probes NASA plans to send near the Sun and distant planets later in this decade.

While flight-testing of these projects is a long way off, some decision as to which center will direct them must be made soon, because each requires three-to-five-year development effort.

Previously, all these projects were within the domain of JPL in its role as the facility having primary responsibility for all space agency unmanned lunar and planetary spacecraft programs.

The Goddard spokesman said center personnel are now trying to determine whether it has the personnel and facilities to undertake all or part of the *Mariner B* and *Voyager* projects.

An affirmative recommendation appears certain.

The spokesman pointed out that while headquarters had requested the study, "no decision has yet been made to assign Goddard to these responsibilities."

• **No repudiation**—Existence of the study was confirmed by a NASA headquarters official, who declared that it casts no reflection on JPL, but is merely an assessment by the space agency of its management capability.

He pointed out that JPL already has a heavy workload because of the *Ranger* and *Surveyor* projects and the early *Mariner R* spacecraft. And he said space agency officials believe Goddard's experience in near-Earth space exploration could be a real benefit to the deep-space programs.

The official also noted that—rather than for primary management responsibility—Goddard may be tapped to do major subsystem work, including awarding of contacts. He admitted, however, that this could easily lead to overall direction of the programs.

JPL's management of the *Ranger* hard-landing lunar spacecraft project recently was criticized in a report by a special committee of NASA scientists. Simultaneously with its release, JPL announced a shakeup in management. Its lunar and planetary projects were combined under one director and the *Ranger* project officer was replaced.

During the last session of Congress NASA's contract with JPL was attacked by Rep. Albert Thomas (D-Tex.), chairman of the House subcommittee that approves NASA appropriations.

About two years remain in the three-year contract. Under its terms, NASA pays a $2.2 million fee to JPL, plus all costs of the spacecraft programs under its direction.

Commenting on the contract, Thomas told NASA officials, "I hope you do not make any more contracts without submitting them to this committee. Not that we do not trust your judgment, we just do not like this setup."

The Congressman was especially critical of the $1.2 million fee which is paid to Cal Tech, indicating he believed NASA got little for its money.

Albert F. Siepert, director of the space agency's Office of Administration defended the fee, pointing out that it was paid for the association of the institution to the lunar and planetary program as an eminent academic institution. ⁂

NASA Invites Bids on New Satellite

TWENTY-FOUR firms have been invited by NASA to bid on the development of a 4000-lb. micrometeoroid satellite.

The satellite, one of the heaviest planned by the space agency, will study the effects of meteoroids and micrometeoroids on spaceflight in a near-Earth environment.

At least two of the satellites will be launched as secondary missions on the eighth and ninth test flights of the *Saturn C-1* booster. The satellite's orbit will range from 100 to 200 miles, with an estimated lifetime of one year.

Deadline for submission of bids is Jan. 17. Contracting responsibility has been assigned to the Marshall Space Flight Center, which is developing the *Saturn* rocket.

Space agency plans call for an erectable satellite that will have an umbrella-like shape. It will have a surface area of more than 2000 ft. when fully extended.

Officials said the large size of the satellite will permit a skin much thicker than normally used in smaller satellites. The greater surface will also provide more data on the magnitude and distribution of meteoroids.

The satellite will be many times heavier than the 187-lb. *Explorer XVI* launched for the same purpose by a *Scout* rocket Dec. 16. The heaviest announced weight of a U.S. satellite was 8750 lbs. for Project Score, the orbiting *Atlas* rocket.

The firms invited to bid are Fairchild Stratos Corp., Ford Aeronutronic, General Dynamics/Astronautics, General Electric Co., Goodyear, Hayes Electronics, Martin Marietta Corp., Northrop Corp., Parametrics, Radiation Inc., RCA, Spacecraft Inc., Space General, Space Probes Inc., Space Technology Laboratories, Ling-Temco-Vought, Inc., Hughes Aircraft Co., The Boeing Co., Douglas Aircraft Co., Inc., McDonnell Aircraft Corp., Lockheed Aircraft Corp., Avco Corp. and IBM.

Skybolt Controversy Intensifies

Cancellation hit by critics in Britain and on Capitol Hill; switch to Polaris for Britain may undercut plans for MMRBM

CANCELLATION of the Air Force's *Skybolt* air-launched ballistic missile program has set off a widening set of complex repercussions—including a hot Congressional debate and a new threat to the planned Mobile Mid-Range Ballistic Missile *(MMRBM)* system.

The Air Force last week announced that the program had cost $353.2 million through the end of 1962. An AF report on how *Skybolt* R&D spending will be phased out, and how the knowledge gained will be applied to other programs, is due to be delivered this week.

At the same time, the Air Force continued to insist that the sixth and final flight test of the weapon, on Dec. 22, was a success. The Defense Dept. earlier described the launch from a B-52 bomber as a failure.

There were two other hassles over the termination of the program. In Britain, where the entire future of that nation as an independent nuclear power was thrown into jeopardy by the decision, there was condemnation of the U.S. from some normally pro-American Conservative Party members. And some Labor Party members, usually critical of U.S. policy, supported the *Skybolt* decision because they believe Britain should get out of the nuclear arms race.

In Washington, senators and representatives were lining up on both sides of the question with little regard for party affiliation.

Meanwhile, Douglas Aircraft Co., prime contractor for *Skybolt,* announced at Santa Monica, Calif., it would have to lay off 4000 workers at its Missile and Space Division because of the cancellation.

Despite the furor, it was apparent that there was no prospect whatever that the Administration would reverse its decision to dispense with *Skybolt* and offer the British some *Polaris* missiles as a substitute.

• **MMRBM future dark**—The *Polaris* development quickly cast new doubt as to the future of the *MMRBM.* The long-range view is that there is now less justification than before for adopting such a land-based system. Pentagon sources say acceptance of *Polaris* by Britain—and perhaps France—probably would eliminate the need for *MMRBM.*

Even before the Kennedy-Macmillan Nassau conference which sealed the fate of *Skybolt,* there was considerable caution and hedging in consideration of *MMRBM* in the Fiscal 1964 budget.

Even more interesting, with regard to both the *MMRBM* and the British-bought *Polaris,* is the promise which British Defense Minister Peter Thorneycroft made to Conservative members of Parliament that a *Blue Steel* Mark 2 missile with a range of 800 miles will be developed—and probably a new, longer-range ramjet standoff bomb as well.

Whether this development will replace *Polaris* in British thinking or merely serve until *Polaris* comes into use has not yet been determined. It appears, however, that *Polaris* will still be bought by Britain. Technical and naval teams are now being sent to the U.S. to work out delivery arrangements.

• **Congressional cauldron**—In the wake of protests by Senators Goldwater (R-Ariz.), Symington (D-Mo.), Engle (D-Calif.), Robertson (D-Va.) and others, Sen. William Proxmire (D-Wis.) supported the cancellation of *Skybolt*—thus becoming the first member of Congress to back President Kennedy's action.

The coming *Skybolt* battle on Capitol Hill, he said, "will once again see Congress appropriating hundreds of millions of dollars for an obsolete weapon system and the Kennedy Administration having the good judgment and courage not to spend it."

He added that the Air Force will be aided in its "Save Skybolt" drive by management of companies to whom the program is vital, by labor unions whose members face unemployment without the program, and by communities that face depression if the cancellation sticks.

The most potent pressure of all, he concluded, " . . . is the most irresistible psychology that it's political suicide to vote against any proposed defense appropriation." ⌘

AEC Sets Up SNAP-50 Program Office

THE ATOMIC Energy Commission has taken a big step toward becoming a new space agency by establishing a program office late last month to develop the *SNAP-50/SPUR* space powerplant—a highly advanced nuclear unit in the 300-1000 electrical-kw range expected to be operational in the early 1970's.

Established under a recent memorandum of understanding between the AEC, Department of Defense and NASA, the new office will be part of the AEC establishment, reporting to the *SNAP* program manager, Richard L. Kirk (M/R, Sept. 24, 1962, p. 14).

"AEC will have complete responsibility and authority for research and development of all nuclear and non-nuclear components and their integration into an experimental system," according to the memorandum.

Col. Elwood M. Douthett, USAF, was named program manager of the new office. He was formerly director of the Geophysics Research Directorate, AF Cambridge Research Laboratories, Bedford, Mass.

An AF officer was chosen for the post as a result of an agreement reached between the three agencies under Congressional pressure early last fall.

DOD's role is to set up military requirements for the power unit and provide direct project support when it is requested. DOD, moreover, will be responsible—if a DOD mission is involved—for putting the power system into a space vehicle and flight-testing it.

NASA will be responsible for contributing whatever "non-nuclear" components and system research and technology it develops.

Mariner Unlocks Venusian Mysteries

Results of historic flight include evidence that radiation is not intense enough to threaten safety of space travelers

MARINER II has provided a wealth of important new scientific information about Venus, including evidence that the planet probably has no magnetic field and a new estimate of the planet's mass.

Other major findings of the spacecraft, which made its closest approach to Venus Dec. 14, include:

—The planet rotates very slowly, perhaps exposing only one side per year to the Sun. This was buttressed by a radar bounce experiment conducted by Jet Propulsion Laboratory scientists in the October-Dec. 17 period. Results of the experiment indicated that Venus may rotate in a direction opposite that of Earth, perhaps only once every 250 days—25 days more than a Venusian year.

—While solar-flare disturbances were encountered, there were no radiation intensities that would be significantly hazardous to manned spaceflight.

Results of the spacecraft's flight were reported by NASA Dec. 28. Many of the details were also revealed by scientists at the 129th meeting of the American Association for the Advancement of Science in Philadelphia on Dec. 26, and the National Conference of the American Physical Society and the American Geophysical Union in Stanford, Calif., on Dec. 28.

Absence of a magnetic field would mean that manned spaceflights to Venus would not have to cope with drag when approaching and landing on the planet.

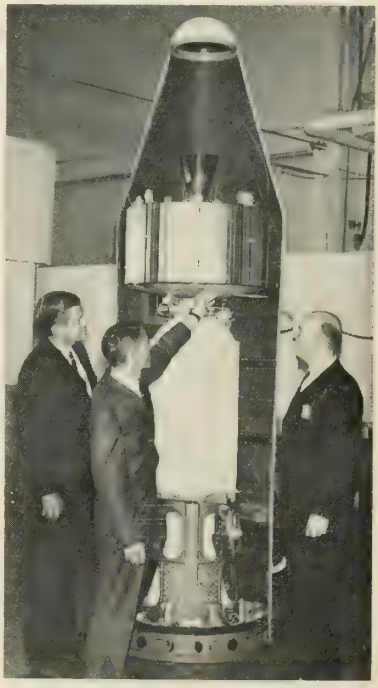
• **Magnetic experiment detailed**—Scientists said that magnetometer readings as the spacecraft passed within 21,594 miles of Venus reported no trace of a magnetic field.

The experiment was designed to measure a magnetic field as small as five gamma. The Earth's magnetic field is 30,000 gamma at the equator and 50,000 at the poles.

The scientists said, however, this does not necessarily mean Venus has no magnetic field, since effects of the solar winds would confine a real magnetic field to a region near the planet. If Venus has the same simple magnetic structure as the Earth, magnitude of its surface field would be less than five to 10% of the Earth's field at the surface.

They pointed out that *Mariner* passed Venus on the sunward side. If it had passed on the opposite side, there is a good chance that even a weak magnetic field would have been detected because *Mariner* would have been pushed out on the other side of Venus by a solar wind.

Another *Mariner* experiment tending to confirm that Venus has a very small magnetic field—or perhaps none—involved an attempt to detect magnetically-trapped belts about Venus. The spacecraft detected an average of only one particle per second during closest approach. This compares with a rate of several thousand particles per second at about the same distance from Earth. Jet Propulsion Laboratory said these observations tend to confirm that slowly rotating bodies have small magnetic fields—reinforcing a theory that planetary magnetic fields are caused by a dynamo action inside a molten core.



Testing Synom for Size

HUGHES-BUILT Syncom satellite prototype is fitted to third stage of reliable Douglas Delta rocket at Douglas Aircraft Co.'s Missile and Space Systems Div. Syncom launch is due early this year.

• **Planet's mass pinpointed**—NASA scientists called the new estimate of Venus's mass—0.81485 times the mass of Earth with a probable error of 0.015%—the most accurate yet. The Earth's mass is known to be about 13 septillion pounds.

Data was obtained by the so-called "two-way Doppler" measurement, involving a round trip by radio signal. Comparison of the outgoing and incoming signal enabled scientists to determine how much the spacecraft velocity was increased by the gravitational field of Venus. This gave scientists the necessary data to determine the planet's mass.

Scientists are now evaluating additional data obtained just before and after planet encounter. This information is expected to further refine their estimates.

Information on the small amount of high-energy-particle radiation was obtained by a large spherical ionization chamber and two matched geiger counters.

• **Radiation ramifications**—NASA scientists said that while solar flares and resulting high-energy particles could be a significant hazard to manned spaceflight, no such events have been observed by *Mariner*.

The *Mariner* experiment reported that high-energy solar particles were generally absent during the flight except for a single solar flare encountered Oct. 23.

The total radiation dose seen by the ionization chamber during that event was only about 0.24 roentgen inside its 0.01-in.-thick steel wall, and the radiation was so non-penetrating that a moderate increase in the wall thickness would have excluded the particles almost entirely.

The Venus radar bounce experiment, which indicated the slow rotation rate of the planet, was conducted by NASA from its Goldstone, Calif., tracking station. The slow rotation rate was already indicated by the absence of any real evidence of a magnetic field around the planet. ⌗

Space Race Strains Soviet Economy

USSR must emphasize one of three areas: ICBM's, missile defense or spaceflight

by Frank G. McGuire

A VARIATION of the old shell game is giving Soviet leaders severe problems in determining which of three possible missile/space courses to follow.

Faced with the alternatives—ICBM production, defense against missiles, or space flights—the Soviets reportedly can pursue only one course of action with any degree of vigor, while proportionately downgrading the other two.

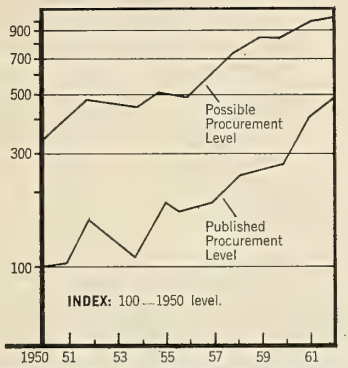
A recently completed series of studies carried out for the Congressional Joint Economic Committee points out Russia's dearth of critical resources for simultaneously pursuing all three areas of activity, and says the assignment of the highest USSR national priority to only one of the areas is inescapable.

Upshot of this evaluation is that equal distribution of resources among all three alternatives would eventually leave the USSR lagging behind the U.S. in all three. To compete seriously in one, the USSR will have to essentially curtail the other two, while maintaining the appearance of pushing them.

In the space program, for example, speculation that Russia's activities were being curtailed early in 1962 may have been prompted by the Soviets, accompanied by offers to cooperate in space, because they wanted to limit the areas of competition.

The survey, consisting of a series of more than 20 papers prepared on specific topics by experts in Soviet affairs, was undertaken to pull together the best and latest information on the Soviet economy and its functioning. Rep. Wright Patman (D-Tex.), the committee's chariman, emphasized that the study is not intended to prove anything, but merely to provide a centralized compilation of data and evaluations.

The study points out that the USSR is faced with more pressing "either/or" choices than is the United States—propositions which are undesirable from the standpoint of competing with the U.S. on a broad front of activities. Much that is significant for the U.S. military effort is contained within the study, which was authored in large part by personnel of government agencies or



ESTIMATES of USSR's procurements in military/space emphasize uncertainties.

government-funded organizations.

One prime consideration for this country is that it be able to exercise some control over the direction and pace of the arms race by selective development of programs. This option has already been exercised in the *Nike-Zeus* program (M/R, Dec. 24, p. 14). To what extent such ability can be utilized to channel the headlong plunge to more and more costly weapons—embodying more and more risk—was not spelled out in the Congressional study.

John P. Hardt, a specialist with Research Analysis Corp., said in his paper on Strategic Alternatives in Soviet Resource Allocation Policy:

"In the military-space programs . . . the conversion to military from civilian production is, for the most part, no longer an open option. . . . The military-space support industries have a relatively fixed, albeit expanding, capacity for some years ahead. This type of capacity may be expanding at a rather impressive rate due in part to the priorities for space set as much as a decade ago, but there is a rather fixed ceiling due to limitations on conversion possibilities from other productive capacity and the long time required to increase the plant, equipment and other labor force required."

Hardt singles out the scarcity of critical resources as the probable cause of the missile "gap" failing to materialize. The Soviets, he says, could probably have produced the calculated number of ICBM's, but only at the price of severely curtailing their missile defense systems and space program. The failure to turn out all the ICBM's which U.S. intelligence indicates the Soviet economy is capable of manufacturing leads experts to conclude that some of the needed resources were channeled into the other two alternatives.

Regarding the three basic areas of technology competing for available resources, Hardt says "each of these three priority areas must draw on the same limited military-space supporting industries. The costs of each of the programs must be calculated in terms of the alternative programs. How many ICBM's is a missile defense system for Moscow worth to the Soviet leaders? Or will a program to land a man on the Moon justify retarding their offensive and defensive missile programs?"

• **The planned economy**—Although suited for planning of uncomplicated systems, Hardt asserts, the Soviet system of controlling resources, production and other aspects of the national economy is running into great difficulty in the face of the complexities represented by modern weapon systems. New demands on the planning system break down into a combination of factors, of which the weapon system complexity is only one—the other two being the proliferation of claimants for resources and the increasing size and complexity of the Soviet economy as a whole.

"The central problem that keeps reappearing in Soviet discussions is that of improving the planning mechanism while continuing political control of the resource allocation decisions," Hardt's paper states. "One fear of the party leaders might be that the planning technicians might be able to insert their preferences in place of those of the party leaders if the process does not allow for continued political appraisal at the center."

He attributes the reluctance of Soviet leaders to adopt new planning techniques to this fear of loss of control,

as well as to an "understandable" reluctance on the part of planning bureaus to switch to new military technologies and overall modernization that would dislocate the remainder of the plan. In such a change, Hardt says, all of the personal and political relationships of the enterprises concerned are altered.

• **Breakthrough exploitation** — The very breakthroughs which gave the USSR its promise of some advantages over the U.S. in certain areas—rocket engine thrust and some missile defense developments—are posing serious economic problems, Hardt contends; he cites the massive allocation of critical resources as the follow-through headache.

The R&D costs of developing an ICBM and perhaps proving the principle of ballistic missile defense, are relatively small compared with the requirements in skilled manpower and special materials necessary for mass production of these systems. And it is only mass production beyond the prototype stage which will bring about the effects necessary to affect the balance of power.

Hardt's thesis holds that the rate of expansion of military-space support industries may run significantly behind the rate of technological and production opportunities open to the Soviets, and that this rate is limited by scarcities in skilled personnel and vital materials.

A corollary proposition presented in the study is that the nature of the planned economy is such that breakthroughs must be predictable and actually worked into the plan as far as 20 years in advance. It is only by this method that the master plan can work with any semblance of efficiency without being totally disrupted every time a new technological development makes many of the existing techniques obsolete.

Paul K. Cook, writing on the administration and distribution of Soviet industry, comments: "To the specialist, as well as to the dispassionate amateur, it seems a real miracle that the state-owned and state-operated industry of the Soviet Union has progressed to the extent it has. . . . It is a tribute to the Soviet managerial class that they are able to function within such a system."

With the time factors involved, however, there is little choice for decision-makers. As Hardt points out, a five-year gestation period from decision to mass production is not uncommon, and a decade is sometimes the case.

It is this lengthening "time horizon" for economic decisions, compounded by the incontrovertibility of much of the required industrial capacity and labor force. which Hardt feels makes the type of decision required for extremely expensive space programs highly inflexible.

"Therefore, it might be generally stated that the Soviets now have either decided for or against a program to land a man on the Moon, or they may not stand a chance of success in this decade. To the extent that this generalization holds, it places upon the Soviet leadership a heavy requirement to correctly foresee their own future preferences and carefully weigh the alternatives foregone before their future decisions are frozen by decisions of the moment. Premier Khrushchev is using up, today, in weapons systems decisions many of the options of his successor and preconditioning the resource allocation pattern that will be his successor's inheritance."

• **Military expenditures** — The actual extent to which the USSR is financing its military establishment is not clear from official figures, and additional considerations must be taken into account. The Soviet national budget is prepared under five general headings: National Economy, Social-Cultural Measures, Defense, Administration, and Other.

The budget for 1961 called for 15% of the expenditures to go to the defense establishment, but this is probably low. The details of the defense allocation have never been published, and it has been generally assumed that line items from other portions of the budget have been applied to defense purposes without the defense label. For example, Prof. J. G. Godaire, discussing the claim of the Soviet military establishment on the economy, puts much of the scientific research in this category.

"The reported allocation for scientific research, largely under 'Social-Cultural Measures' has had large annual increases, with the 1962 planned level standing at 400% of the 1953 level," Godaire states. "There are institutional reasons for believing that this allocation encompasses a considerable amount of research and development for complex military equipment such as aircraft and missiles and for nuclear energy and space activities."

He continues: "The published details for the constituent activities under the heading 'National Economy' (also) consistently fail to explain the total allocation, and the unexplained portion has at least tripled since 1950, whereas the total budget has only doubled during that time. Finally, the general expenditures residual category 'Other' at 5 to 10% of the total, has continued to exist over the period without any really adequate explanation for its purpose."

Summarizing the defense expenditures and introducing those portions of other budgetary allocations which he feels are applied to defense purposes, Prof. Godaire prepared a chart showing the general trend of both the published and the possible Soviet military budget since 1950, using that year's outlays as an index number of 100. The chart indicates an increase as of 1962 in the possible military outlays exceeding 1000 on this scale, while the published figures have increased from the base line of 100 to over 500.

The purpose of this logarithmic scale, Prof. Godaire points out, is to show in relative terms the behavior of the series of allocations over time with respect to each other and to illustrate the substantial range of uncertainty engendered by Soviet pronouncements.

In purchasing power, there is also a pitfall regarding translation of rubles into dollars at the official rate of exchange. On July 8, economist Martin J. Kohn points out, Premier Khrushchev responded to U.S. defense spending increases by boosting his military budget from 9.26 billion rubles to 12.4 billion rubles. This 34% increase, at the official rate of exchange, works out to a jump of $3.5 billion. However, purchasing power ratios for defense goods are believed far more favorable, and the increase works out to nearly $8 billion.

• **Future prospects**—A crystal-ball approach was taken at JEC hearings by Roger Hilsman, director of the State Department's Bureau of Intelligence and Research, who noted that the Soviet economy overall has grown at the rate of about 6% over the last 10 years.

"What is so interesting about this figure is not that it is so high but that it is so low," he told the committee. "Considering the enormous efforts and sacrifices forced upon the Soviet population, one should have expected a faster rate of progress. . . . The Soviet economic system—as has been candidly acknowledged by Oscar Lange, the well-known economist who heads the Polish Economic Council—the Soviet economic system is in the nature of a war economy. . . . It has been said occasionally that Khrushchev faces greater pressures in his decisions on resource allocations than did Stalin."

Hilsman pointed out that although the Soviet national product has almost doubled since the early 1950's, there is also a greatly increased demand upon the resources to be allocated.

Additionally, with the rise of the European Common Market, there will be increased pressures upon the Soviet Union to allocate its resources to its own best economic advantage.

Hilsman concluded: "The same is obviously true of the USSR's programs for military and scientific ends. These, in turn, will determine how much will be left for investments that more or less directly will benefit the consumer; it will finally determine how much will be available for consumption. . . .

"Khrushchev and other so-called 'revisionists' in the Communist world of today would blanch if they could see ahead the revisions which the 1960's will force upon their system." ⁂

Engineer 'Drought' Hasn't Hurt NASA

Space agency exceeds recruiting goals; President will send Congress plan designed to encourage graduate study

by Heather M. David

INDUSTRY probably will be hit
der than NASA by the impending
ortage of scientists and engineers.

The space agency has thus far had
le trouble attracting large numbers of
aduates into its ranks. This year it
ok 858, when it had a goal of about
0. NASA employs a total of about
00 professionals in-house, but at the
me time industry needs at least
,000 professionals to fulfill its NASA
ntracts.

However, the converging lines of
sing demand and declining supply will
ave to be faced by both government
d industry. For the 10th year in a
w, college engineering enrollments
ave dropped. The percentage of en-
neers in this year's freshman class is
ss than 6%—down from 6.6% last
ear.

More alarming, perhaps, is the fact
hat dropouts are rapidly increasing. In
950, 70% of each class made it to
accalaureate. Last year, only 45% did.
f the trend continues, only 38% will
urvive in 1965.

This high rate of dropouts, slashing
lready smaller classes, is causing the
umber of graduate degrees to plummet
o all-time lows. The Engineering Man-
ower Commission reports that 6%
ewer degrees (making the total about
3,200) were awarded in 1962 than in
1961. By 1965, says EMC, only 25,000
may graduate.

• **Why continued drop?**—The EMC has some new explanations. It submits that while larger percentages of the population now go to college, these increases are at the lower intellectual levels, which are not fitted for engineering the EMC says.

Another theory ventured is that after World War II a great number of veterans with technical experience were steered toward engineering. The decreasing number of veterans may have affected engineering enrollment.

Deans of colleges interviewed again attributed the drop to higher entrance standards.

• **Demand soars** — Total engineering demand will shoot up 33% in the next decade, says the Engineering Manpower Commission. An earlier National Science Foundation survey forecasted a doubling of demand by 1970.

The space program must take the lion's share. If NASA continues to hire professionals at a rate of about 1500 new people a year (not including about 500 replacements), industry must have perhaps 12,000 to support it.

• **President acts** — President Kennedy will submit to the 88th Congress a program to aid engineering study.

The program, if passed, will cost $580 million next year, $660 million in 1966, $710 million in 1968 and $760 million in 1970. Set up by a special advisory committee, it is designed to accelerate graduate training as a means of filling the national need in engineering, mathematics and physical sciences.

The committee's aims:

—Increase engineering Ph.D.'s from 3000 in 1960 to 7500 in 1970.

—Increase the number of students who complete one year of advanced study from 3000 to 30,000 by 1970.

—Decrease the dropout rate of first-year graduate students so that three-fourths would get master's degrees, one fifth would get doctor's. Current rates are two-thirds master's, one-sixth doctor's.

• **Help from technicians?** — The Presidential advisory report also aims to deal with the problem of increasing the number of qualified technicians and "subprofessionals" at a future date.

NASA has a good formal training program for technicians; many have emerged from it able to solve problems the engineers couldn't. For instance, it was a technician who devised the method of folding the *Echo* balloon so it emerged undamaged from its canister in space and inflated automatically.

But NASA has a positive education requirement, and cannot promote its technicians to become engineers — or support their undergraduate education.

Industry—more flexible in this aspect—may find some solution to its needs by elevating technicians. Some estimates are that even now 50% of the engineering work force in private industry does not have degrees.

Women remain an untapped source of talent. In 1962, the EMC reports, only one out of 360 engineering degrees was awarded to a woman. Only one in 175 students is female.

The Soviet Union and Red China, who rely heavily on women, have been steadily increasing all their engineering graduates. In 1962, about 125,000 graduated in the USSR. Red China is thought to have increased its engineering classess by 80% in the past ten years.

• **Other solutions**—One of NASA's prime weapons against the time of crisis in work force shortage is a program to improve the caliber of its professional staff.

Sometime this year it will begin using a personality index it has developed to single out the more creative persons (M/R, May 7, 1962, p. 17). This will be one of the tools used in hiring.

NASA has now used the index on almost all its centers, and has found that its highly gifted professionals have the same answers to a high percentage of the 300 or so questions asked.

The significance of the index is that it deals with actual biographical material, and is in no way a test. Thus it requires no time limit or supervision and creates no nervous blocks for the applicant.

Eventually, the space agency hopes to make it available to other government agencies and industry.

• **NASA problems**—Inequalities in pay scales between government and industry are gradually being worked out. A government-wide pay raise last year has made lower-level pay scales much closer to those of industry.

Executive salaries, however, remain much lower than industry's. NASA has 25 top jobs, paying from $16,500 through $21,000, which it has not been able to fill.

The next Congress has promised to deal with the upper levels, since the last pay raise brings some of the lower-level jobs quite near the top salaries. The upper limit of grade 15 will be about $19,000 by next year, while grade 18 will be only $20,000. ⌘



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Technical Countdown

ELECTRONICS

Minified S-band Amplifier Built

Engineering tests of a Raytheon-developed S-band telemetry amplifier have been completed by the firm's Missile & Space Div. and fabrication of a production prototype has begun. Tests with the breadboard version of the unit reportedly demonstrated 20-db gain and 20-watt output with 65 watts of 28v prime power. The amplifier, which Raytheon expects will represent significant advances in size and efficiency, uses the firm's QK997 amplitron. Prototype volume is expected to be about 110 cu. in., with weight at less than 6 lbs. Qualification testing of the prototype is expected to begin next week.

New Duplexer Carries Big Load

A Y-circulator has been operated successfully at power levels well over a megawatt—possibly a record for this type component. Built by Electronic Communications, Inc., for the Navy, it will be used as an antenna duplexer for shipboard radars.

'High' Temperature Superconducting Magnet

Westinghouse Research scientists have brought the superconducting magnet field out of its liquid helium bath, making it available in air at room temperatures. The external field magnet owes its existence to the development of a high-field solenoid with a sizable inside diameter and the design and construction of a helium Dewar, which keeps the coil immersed but makes the magnetic field available outside the container. The air-core superconducting magnet has a 2-in. diameter. Subtracting the container space leaves a working diameter of 1 in. in a magnetic field of 30,000 gauss. A conventional electromagnet producing a comparable field would weight several tons and require 25,000 watts of continuous power. The Westinghouse unit weighs 5 lbs. and can be energized with an auto battery.

Rendezvous Control Computerized

Using a simulated spacecraft and a battery of analog computers, Westinghouse Defense Center engineers have developed a space capsule in which computers do most of the control work, leaving the astronaut free for other activities. Six meters tell the astronaut the position and behavior of his vehicle in six different axes. Three tell him his position in relation to his rendezvous target longitudinally, laterally and vertically. The other three axes are controlled by an automatic-pilot system operating from a different computer, which fires rockets controlling pitch, roll and yaw. Manual override is provided in the prototype development.

MATERIALS

Ablative Cork Composition in *Minuteman*

A cork composition designed to protect *Minuteman* and *Polaris* missiles against aerodynamic and exhaust heating is in production at Armstrong Cork Co. The ablative material is used on *Minuteman* third stage as insulation against aerodynamic heating and on experimental second-stage *Polaris* units as exhaust insulation. Armstrong can vary the material binder components to permit a wider range of applications. The firm also developed the adhesive for both missiles.

Maskless Thin-Film Process Developed

General Dynamics/Astronautics is perfecting a maskless process to produce thin-film circuits. In the proprietary method, continuous films of three metals are deposited on a substrate within a vacuum chamber. Then all other processing is done outside the chamber by photo-chemical techniques. This eliminates mask holding and jig realignment within the vacuum chamber, permitting a high degree of refinement. One operator and one vacuum station can produce up to 2000 passive circuits a day. The firm has developed selective etching solutions and anodization techniques that allow the processing of each material without affecting any others in the substrate.

Microwave Noise Sources Calibrated

The Radio Standards Lab of the National Bureau of Standards is initiating a service to calibrate waveguide noise sources in the microwave frequency region. This service presently is offered in WR90 waveguide at three selected frequencies—9.0, 9.8, and 11.2 gigacycles. Calibration of interlaboratory standards is made by comparison with selected gas-discharge noise sources used as national working standards. These working standards are calibrated periodically against the National Standard Microwave Noise Source recently developed in the Radio Lab.

Silicon Sliver Salvage Now Possible

A new technique developed by Geoscience Instruments Corp. will make possible the salvaging of silicon end-slices and scraps currently considered waste in the semiconductor industry. With the GIC process, the endpieces and scrap obtained in slicing are sorted and returned as double-face lapped wafers either to exact specifications or about two mils thicker than final requirements. All unusable scrap is returned and charges are made for good slices only. A minimum of 2000 pieces must be supplied, says GIC, and while no guarantee is offered on yield, these are approaching 80%, according to GIC.

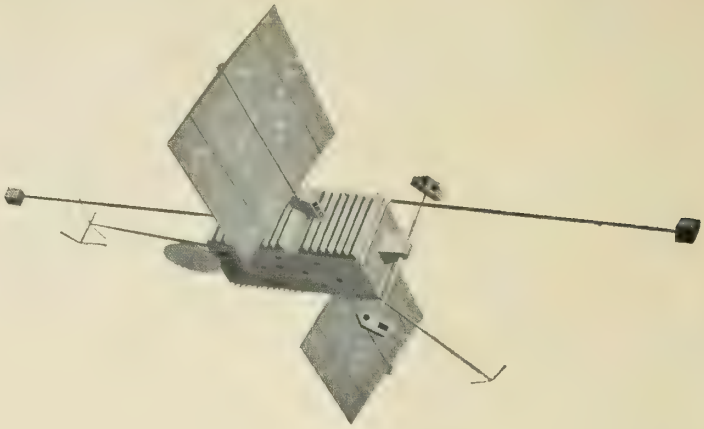
Navy Publishes X-Ray Reference Manual

Scientists at the Naval Ordnance Lab, White Oak, Md., have compiled an X-ray reference manual consisting of 124 films illustrating the various types and degrees of defects in thin-wall, high-strength steel castings. The radiographic standard establishes a basis for military and civilian procurement of high-quality castings for missile and spacecraft applications. Titled "Reference Radiographs for Steel Castings for Aerospace Application," the manual is available from the American Society for Testing and Materials, 1916 Race St. Philadelphia 3, Pa. at $170.00 per copy.

PROPULSION

UTC Tests Filament-Wound Liquid Engine

An advanced, lightweight, glass fiber rocket engine has withstood 1147 seconds of sustained operation at 4000 lbs. thrust at United Technology Center, a division of United Aircraft Corp. Thrust chamber temperatures reached 5000° F in the 95-lb., 30-in. long rocket engine. Ablative cooling techniques were used, coupled with the firm's "aeration" throttling system. The engine reportedly could take another five minutes firing. The throttling system held the thrust to 4000 lbs., but the engine is capable of levels up to 16,000 lbs., says UTC. The firm may propose the unit for lunar landing applications.



OGO EGO POGO

Meet OGO, the curious-looking object you see above. Actually, OGO is the family name; it stands for Orbiting Geophysical Observatory. There are two members of the OGO family: EGO (Eccentric Geophysical Observatory) and POGO (Polar Orbiting Geophysical Observatory).

EGO's purpose is to gather and transmit data on energetic particles and other geophysical phenomena. It will be launched into an eccentric orbit by an Atlas-Agena B vehicle from Cape Canaveral late next year.

POGO will be boosted into a polar orbit by a Thor-Agena B from the Pacific Missile Range in early 1964. Its assignment will be to send back information about the atmosphere and ionosphere, particularly over the North and South Poles.

If you are an engineering or science graduate with one or more degrees from an accredited college or university and appropriate experience, you may qualify for participation in history-making projects such as these.

Right now NASA Manned Spacecraft Center in Houston, Texas, has several key openings. They include:

☐ Electrical or Electronics Engineers, with experience in radar RF systems, telemetry or other missile tracking systems;

☐ Senior Electronic Engineers to analyse and recommend instrumentation programs;

☐ Flight Systems Engineers, experienced in the use of analog and digital computers, to solve flight operations and other research and development problems;

☐ Aerospace Engineers, experienced with flight simulators in the training of test pilots and flight personnel. Pilot experience is also desirable.

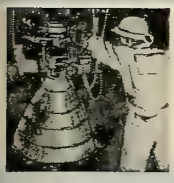
Send a complete resume to: Mr. J. Galloway, Dept. SHC, NASA Manned Spacecraft Center, Houston 1, Texas.

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PROJECT	CONTRACTORS	DESCRIPTION	STATUS
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR (X-20)** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sunstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; officially redesignated X-20, but either name may be used; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT; first DYNA-SOAR flight scheduled for 1965
ECHO (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; first of two ballistic shots planned in 1962 from AMR was successful
★**GEMINI** (NASA)	McDonnell prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Westinghouse, rendezvous radar	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, 1963; manned and rendezvous flights, 1964-65; AF to get 4-5 capsule program
LUNAR LOGISTICS VEHICLE (NASA)	Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp.	1500-lb. spacecraft bus to carry support payloads to the Moon; initial use on SATURN C-1B; 20,000-lb. bus would be used with C-5	Development expected to begin in 1963 after approval of FY '64 funds; Cost expected to run to $500 million; contract expected in 1963
★**MANNED ORBITING DEVELOPMENT STATION** (Air Force)	No contractors announced	20,000-lb. manned space station for testing components and techniques in the space environment; TITAN III-C booster	Program not approved for development, AF spending approx. $6 million in FY '63 for studies; NASA also planning larger (150,000-lb) lab for 1966-67
★**MANNED SATELLITE INTERCEPTOR** (Air Force)	No contractors announced	Spacecraft capable of rendezvousing, inspecting and, if necessary, neutralizing hostile satellites	Not approved for development
★**MARINER** (NASA)	JPL, prime	450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by Aug. 1962 unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14.; six MARINER flights planned
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY will make two 24-hour flights this year to end MERCURY program
MIDAS, PROGRAM 239A (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; program being re-oriented from precise orbit satellite system to random orbit system due to technical difficulties with IR system; pushed back into development cycle
NIMBUS (NASA)	Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras	2nd generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for late 1963; second, six months later; four R&D satellites, four Weather Bureau satellites planned
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, SATURN C-1	First flight scheduled in 1964; two more in 1965
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; nine other shots planned—five in '64 and four in '65

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; 10 more flights planned; advanced OSO studies by Ball Bros., Republic and STL
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D; Ranger VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; program extended through 1964
REBOUND (NASA)	No contract announced	System of three rigidized multi-launched low-orbit passive communications satellites; ECHO follow-on completed in March; ATLAS-AGENA booster	First orbital flight scheduled for 1963; experiments to be conducted jointly with Air Force
★**RELAY** (NASA)	STL, project coordination and systems planning; RCA, prime	150-lb., spin-stabilized, wide-band, 700-3000 mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; power failed after satellite attained orbit; three more in 1963; advanced RELAY under study
★**SATELLITE INSPECTOR, PROGRAM 706** (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system	R&D; formerly known as SAINT; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, probably based on a manned system using GEMINI capsule
★**SAMOS** (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300 mile circular polar orbit	Development; scheduled to be operational late 1962; advanced SAMOS under development
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched early in 1963 with Hughes and Lewis Center engines
SLOMAR (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Orbiting Development Station
SURVEYOR (NASA)	Hughes, prime; Martin, SNAP device	750-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights 1964; seven soft-landing vehicles planned; five lunar orbiters also scheduled; CENTAUR difficulties may cause payload reductions
SYNCOM (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55-lbs.; capable of accommodating one full duplex radio telephone channel	Development; first launching using THOR-DELTA scheduled this month; 500-lb. advanced SYNCOM to be developed
TELSTAR (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10 highly successful
★**TIROS** (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3,000 mi. apogee)	R&D; Six satellites launched; all successful. Program may be expanded to allow 8 (5 NASA, 3 Weather Bureau) launches
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime; Martin SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; TRANSIT 5-A failed after achieving orbit in December
VELA-HOTEL (ARPA)	STL, prime; Los Alamos Scientific Lab/ Aerospace, payload	12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; three satellites placed in one orbital plane with three more in a plane 90° to the first; booster, ATLAS-AGENA	Initial launchings expected during this calendar year
★**VOYAGER** (NASA)	JPL	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface; spacecraft weight, 2400 lbs.	Study; development to begin this year; first flight 1965; MARS orbital flight 1966; SATURN C-1B-CENTAUR under consideration as booster

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000 mph flight at edge of space; each rocket engine develops 57,000 lbs. thrust; re-entry high angle of attack fights providing data for X-20	Powered flights in progress; unofficial records set: altitude (314,750 ft) and speed (4159 mph); X-15 will be used as trainer for X-20



Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-pound upper stage designed to go into orbit with payload; all-inertial guidance; 16,000 lbs. thrust re-start capability. AGENA D flight tested	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
CENTAUR (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date
DELTA (NASA)	Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 430 lb. payload capability in 500 mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational early 1963
★**NOVA** (NASA)	General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st stage thrust)	Study to determine characteristics; operational target date 1970 time period
★**ORION** (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift 1000 tons into orbit	Studies; feasibility proven in Project PUT-PUT series; decision on continuing program pending
★**ROVER** (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: KIWI B-4A tests, prototype of NERVA engine, under way	First Rover flight test expected 1966-67; operational vehicle 1968-69
★**SATURN C-1** (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 20,000 lbs. into 345-mi. orbit	Three flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages 1963
SATURN C1-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 30,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; may also be used as a supply vehicle
SATURN C-5 (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-1B: 5 F-1 engines; S-11: 5 J-2 engines; S-IVB: J-2 engine; 100-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1965; prime booster for APOLLO missions; will also be used to boost Orbiting Space Station
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 250 lbs.
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability about 900 lbs. in 300 mi. orbit; upper stage has restart engines	THOR-ABLE phased out. Used in TRANSIT, ANNA, and other satellite programs
TITAN III (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight May '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 12 TITAN II core vehicles (A version), 5 full TITAN III's (C version); operational in 1965



Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years; orbits Earth; perigee 353 km, apogee 1669 km, period 105.2 min.; not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits Earth; perigee 652 km, apogee 3938 km, period 133.8; transmitting 108.024 mc.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. In orbit around Sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth; perigee 562 km, apogee 3288 km, period 125.3; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle; apogee 1.142 au, perigee 0.9871 au; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 493 km, apogee 3735 km, period 129.6; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 546 km, apogee 1082 km, period 101.1; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 311.6 day period; aphelion .9951 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; perigee 681 km, apogee 759 km, period 99.1; not transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 355 km, apogee 623 km, period 94.3. Not transmitting.

★**MIDAS II** (5000 lbs.). U.S. Launched 5/24/60, est. life 8-15 years. Orbits Earth; perigee 380 km, apogee 595 km, period 94.2. Not transmitting.

★**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60. est. life 50-200 years. Orbits Earth, perigee 605 km, apogee 1066 km, period 101.6. Not transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40-lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 609 km, apogee 1059 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 1048 km, apogee 1906 km, period 115.4.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 969 km, apogee 1210 km, period 106.8. Not transmitting.

EXPLORER III (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 412 km, apogee 2265 km, period 112.4. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 594 km, apogee 755 km, period 98.2. Not transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 464 km, apogee 551 km, period 94.8.

VENUS PROBE (1419 lbs.,) Russia. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 660 km, apogee 2484 km, period 117.4.

EXPLORER X (78 lbs) U.S. Launched 3/25/61. Position uncertain.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 488 km, apogee 1779 km, period 107.8. Measures gamma rays from the stars absorbed in Earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs.; GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 879 km, apogee 999 km, period 103.8. GREB-INJUN—perigee 880 km, apogee 999 km, period 103.8. Transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: 136.5 GREB III and INJUN failed to separate.

★**TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 763 km, apogee 792 km, period 100.3.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits Earth, perigee 3344 km, apogee 3545 km, period 161.5.

EXPLORER XII (83 lbs.) U.S. Launched 8/16/61. Insufficient observations.

★**MIDAS IV** (3500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3477 km, apogee 3774 km, period 166.0.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee 916 km, apogee 1145 km, period 105.6. Damaged by radiation from U.S. July 9 nuclear test.

★**TRAAC** (240 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee, 984 km, apogee 1080 km, period 105.6. Damaged by radiation from U.S. July 9 nuclear test.

RANGER III (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; lunar probe failed to impact, went into heliocentric orbit; aphelion 1.160 au, perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; apogee 827 km, perigee 726 km, period 100.3. Transmitting 136.23; 136.92 mc.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 554 km, apogee 585 km, period 95.9. Resumed transmitting on 136.744 mc. in latter part of June after stabilization lapse on May 22.

★**COSMOS II** (?) Russia. Launched 4/6/62. Orbits Earth; perigee 194 km, apogee 1067 km, period 97.2. Transmission data not known.

★**ARIEL: INTERNATIONAL SATELLITE** (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 383 km, apogee 1208 km, period 100.7. Damaged by radiation from U.S. July 9 nuclear test. Transmitting 136.403 mc.

★**COSMOS V** (?) Russia. Launched 5/28/62. Orbits Earth; perigee 187 km, apogee 1004 km, period 96.5. Transmitting.

★**TIROS V** (285 lbs.) Launched 6/19/62. Orbits Earth; perigee 598 km, apogee 965 km, period 100.5. Transmitting 136.235; 136.922 mc.

★**TELSTAR I** (170 lbs.) Launched 7/10/62. Orbits Earth; perigee 946 km, apogee 5642 km, period 157.7. Transmitting 136.05 mc.

★**COSMOS VIII** (?) Launched 8/18/62. Orbits Earth; perigee 255 km, apogee 512 km, period 92.1.

MARINER II (447 lbs.) Launched 8/27/62. Heliocentric orbit. Planetary spacecraft came within 21,594 mi. of Venus Dec. 14. Transmitting.

TIROS VI (281 lbs.) Launched 9/18/62. Orbits Earth; perigee 690 km, apogee 707 km, period 98.7. Transmitting 136.235; 136.922 mcs.

ALOUETTE (300 lbs.) Launched 9/29/62. Orbits Earth; perigee 1001 km, apogee 1032 km, period 105.5. Satellite built by Canada; launched by U.S. transmitting 136.979 mcs.

EXPLORER XIV (89 lbs.) Launched 10/2/62. Orbits Earth; perigee 501 km, apogee 98,288 km, period 2184.6. Transmitting 136.44 mcs.

EXPLORER XV (98 lbs.) Launched 10/27/62. Orbits Earth; perigee 306 km, apogee 17,608 km, period 314.7 min. Transmitting 136.101 mcs.

ANNA 1B (350 lbs.) Launched 10/31/62. Orbits Earth; perigee 1081 km, apogee 1179 km, period 107.8. Transmitting 54; 162; 216 and 324 mcs.

MARS I (1965 lbs.) USSR. Launched 11/2/62. Expected to come within 621-6831 miles of Mars on June 25, 1963. Transmitting.

INJUN 3 (40 lbs.) Launched 12/13/62. Orbits Earth; perigee 248 km, apogee 2779 km, period 116.3.

RELAY I (172 lbs.) Launched 12/13/62. Orbits Earth; perigee 1334 km, apogee 7421 km, period 184.9. Transmitting 136.140; 136.620 mcs.

EXPLORER XVI (222 lbs.) Launched 12/16/62. Orbits Earth; perigee 746 km, apogee 1183 km, period 104.3. Transmitting 136.858 mcs.

TRANSIT 5A (135 lbs.) Launched 12/19/62. Orbits Earth; perigee 649 km, apogee 786 km, period 99.2.

COSMOS XII (?) Launched 12/22/62. Orbits Earth; perigee 211 km., apogee 450 km.; period 90.45. Transmitting 19.995 mc.

SECRET AF SATELLITES:

- Launched 3/7/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 223 km, apogee 491 km, period 91.8.
- Launched 4/9/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 2786 km, apogee 3409 km, period 153.0.
- Launched 8/23/62. wt. unk. BLUE SCOUT. Orbits Earth; perigee 618 km, apogee 855 km, period 99.6.
- Launched 9/1/62. wt. unk. ATLAS-AGENA. Orbits Earth; perigee 293 km, apogee 640 km, period 94.0.
- Launched 5/15/62. wt. unk. THOR-AGENA B. Orbits Earth; perigee 290 km, apogee 545 km, period 93.0.
- Launched 6/18/62. wt. unk. THOR-AGENA B. Orbits Earth; perigee 347 km, apogee 378 km, period 91.9.
- Launched 10/26/62. wt. unk. THOR-AGENA D. Orbits Earth; perigee 197 km, apogee 5462 km, period 146.6.
- Launched 12/13/62. wt. unk. THOR-AGENA D. Orbits Earth; perigee 233 km, apogee 2786 km, period 116.2.
- Launched 12/14/62. wt. unk. THOR-AGENA D. Orbits Earth; perigee 201 km, apogee 382 km, period 90.4.
- Launched 12/18/62. wt. unk. BLUE SCOUT. No orbital details available.

Parabolascope Advances Antenna Art

Telecomputing Corp. development makes it possible to align panels in the field—preventing distortion

by Charles D. LaFond

LARGE paraboloidal-reflector antennas now can be aligned readily to an RMS deviation from theoretical contour of no more than 0.020 in.

By employing a new optical system called a parabolascope, and by controlling ambient temperature during the measuring process to within a maximum deviation of 3°F, engineers in the Advanced Structures Department of Telecomputing Corp. have developed practical and highly accurate antenna surface measurement for 60-ft.-dia. dishes.

Principal advantage of the company-developed parabolascope—which is essentially an optical rangefinder—is that its use permits antenna panel alignment in the field after all structural components have been placed in position. This, developers say, prevents the contour distortion that normally results from slight changes in joint and member stresses after reassembling such complex structures.

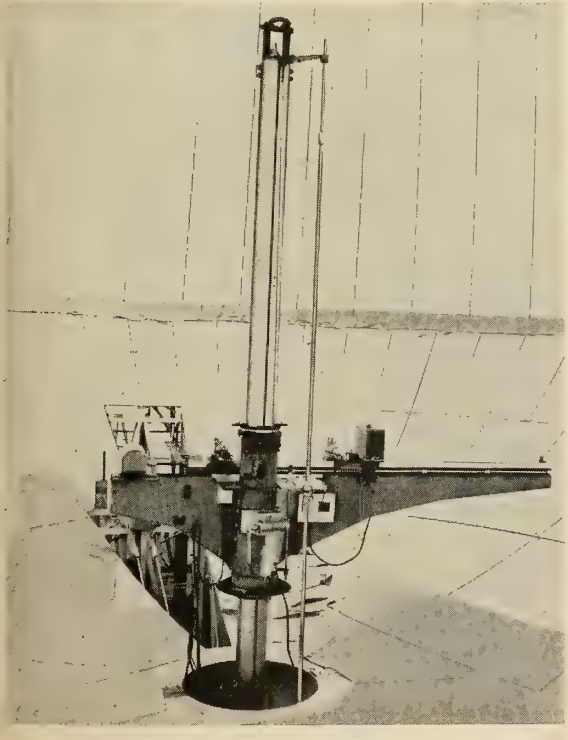
• **Systems surveyed**—Large paraboloidal reflectors for microwave applications function properly only when their reflective surfaces direct energy in phase to the paraboloid focal point. How well they do this is directly a function of surface accuracy.

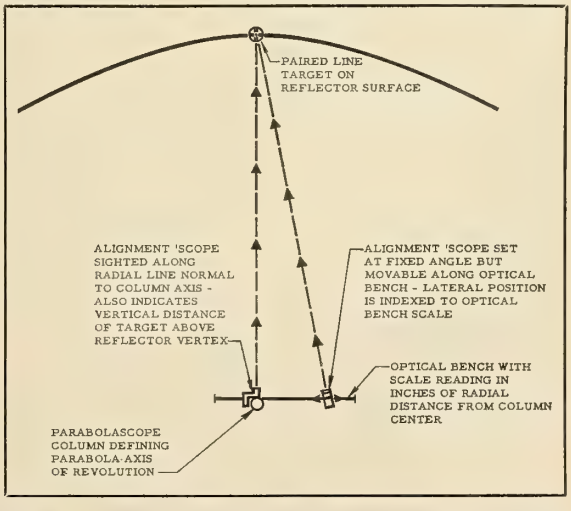
Typically, the surface of a 60-ft.-dia. X-band reflector must be aligned to a tolerance of 0.025 to 0.030 inches. These limits, obtained from the root-mean-square of all individually measured points, represent an alignment accuracy of one part in 14,000 at a distance of 30 ft. Measuring the location of target points to this accuracy under the restraints imposed by reflector configuration and site conditions has been a difficult task in the past, requiring precise equipment and skills.

After a survey of existing measuring systems, Telecomputing Corp. engineers concluded that the answer lay in a system of geometric optics adapted to parabolic configuration and capable of providing coordinate location of target points on the reflector surface. The prime requisite in any such system, according to developers, is that stability must be maintained in individual components and in geometric relationships. Individual components must be so mounted that, as they are moved or used, their relative position is controlled within set limits.

Both the optical alignment system and the object being measured must be highly stable. This is particularly true with large diameter dish antennas. Temperature changes as small as 2°F can result in non-uniform expansion, as individual structural components vary in both mass and surface area. Also, wind can induce both lateral movement and vibration, degrading the measurements.

It is necessary to house the reflector structure in a heated, air-inflated fabric structure to maintain a still, even





LEFT: *Telecomputing Corp.'s parabolascope shown installed in reflector and ready for operation. System calibration instruments are positioned in gaps provided by missing panels. Company has already used the new system to align five 60-ft.-dia. paraboloidal reflectors.* **ABOVE:** *Basic parabolascope geometry in plan view, with basic components and their functions. Developers believe the system is well suited for both alignment and inspection functions because it is not limited in the number or location of points read on a given surface and provides both X and Y coordinates.*

temperature environment during alignment and inspection. Measurements are normally begun approximately one hour after ambient temperature has stabilized to ±1°F.

If, during the measuring process, the temperature range exceeds 3°F—as measured at the vertical and horizontal extremes of the structure—work is halted until a stabilized condition can again be obtained.

• **New approach needed**—The company's design work on the parabolascope began after a survey of alignment methods then available indicated that a new approach was needed. Study results revealed that reflector surfaces should be aligned in the field, after all structural components were firmly positioned.

Templates are not used for field checking because of static and dynamic instability problems and the difficulty of monitoring large template accuracy in the field. It was therefore decided that an optical rangefinder would best satisfy the requirements for an instrument to be both portable and stable under field-use conditions and to permit field checking for accuracy.

In designing rangefinders, the company said, the triangulation system may be based on one of two general options: on a fixed base leg and variable sighting angle; or on a fixed sighting angle and a variable base leg. Because distance to be measured would not exceed 45 ft., and since a fixed sighting angle would reduce system inaccuracies in azimuth-angle readout, developers chose to design the parabolascope with a variable base leg and fixed sighting angle.

The parabolascope employs a centerless ground-steel column supporting a horizontal optical bench that can be raised and rotated about the column. Lateral and angular adjustment of the column are made at the column base to allow it to be centered accurately and plumbed to within one sec. of arc.

The optical bench supports two alignment telescopes. One sights along a radial line from the column center to orient the optical bench and provide a vertical distance measurement relative to the reflector. The other, which is set at fixed angle and moves along the optical bench to provide ranging measurements, is indexed to a linear scale—yielding radial range directly in inches.

Soon after development and experimental use of the instrument, it was found that the choice of optical targets was a significant factor in the accuracy of the overall system. Since the alignment telescopes have a pointing accuracy of only 3½ sec. of arc, a system error of approximately that amount would result if the instrument were used to sight a line or edge target.

Accuracy of the instrument was increased, however, by taking advantage of an observer's great ability to center telescope cross-hairs between paired lines on a target. Use of this paired-line target increased accuracy of the parabolascope to less than one sec. of arc.

The parabolascope serves two major purposes as a measuring device, the company claims: it is used as an alignment tool for bringing the reflector surface to within the required contour tolerance; and it serves as an inspection instrument, measuring deviation of measured surface points from theoretical contour.

In practice, on a given point, both X and Y coordinates are read. The theoretical X coordinate corresponding to the observed Y coordinate is then compared to the actual X coordinate to determine vertical deviation of the point from a theoretical parabola. This deviation is used in adjusting the panel to contour. In the inspection phase, it is used as an accuracy reading.

Before initial use of the parabolascope as an inspection instrument, its accuracy was demonstrated by a triangulation test. Optical targets were attached to an invar scale at a spacing (approximately 6 in.) unknown to the parabolascope crew. Twelve sets of readings were taken of the two targets, with the invar scale on the reflector surface along a radial line placed at different locations on the surface for each position.

With the X and Y coordinates of the targets determined through parabolascope readings, the distance between targets was calculated. Individual distance calculation varied up to 0.017 in. from the distance measured on an optical comparator, and the average of all 12 calculations differed from the measured value by only 0.0004 inches. It was determined from the test that extreme difference errors between the X readings and between the Y readings could be no more than 0.005 inches for the calculated distance error to be held to 0.017 inches. Also the distribution of errors—which proved to be random in nature—was in keeping with the overall accuracy required for the measuring device to attain desired alignment accuracy.

• **Repeatability** — Stability of the parabolascope, the company claims, has been well verified in repeatability tests. Testing involves taking coordinate readings of a series of targets at various random positions, and later readings of the same targets. Comparison of the two sets of readings has indicated a repeatability error of within ±0.003 inches, the engineers claim.

To obtain a reflector surface whose accuracy approaches that of the manufacturing tolerances on individual panels, Telecomputing Corp. employs the following technique:

After a panel is roughly aligned, target points are read at the panel periphery and at several interior points, to give an indication of the placement of the panel as a whole, relative to theoretical contour. The panel then may be positioned to optimum alignment. The major emphasis in this operation is on positioning the panel as a whole, rather than on bringing a few selected points into alignment.

The reflector surface of antennas designed by the company consists of individual panels, which do not contribute significant stiffness to the reflector structure. These individual panels, the company asserts, can be aligned in an optimum position easily, because they are not structurally joined.

A major advantage of this design feature, Telecomputing says, is simplified individual panel replacement—requiring no alignment equipment.

This operation, according to company engineers, has been demonstrated repeatedly, and the replacement panel always has been located within 0.010 inch of the location of the originally aligned panel, with respect to theoretical contour.

In past alignment operations, reflectors have been aligned on the ground. After lifting the reflector into position, coplanar targets are positioned on the reflector structure immediately over the reflector-to-mount attachment points. Once the reflector is in position on the mount, these optical targets are brought to a common plane through vertical adjustment at the attachment points. Thus the reflector surface was returned to the precise condition of alignment attained on the ground.

The firm has used the parabolascope to align five 60-ft.-dia. paraboloidal reflectors to date. These include the Naval Electronic Laboratory reflector on Point Loma, San Diego, Calif.; one at Griffiss Air Force Base, Rome, N.Y.; the two original *Advent* Program reflectors; and one owned by Collins Radio Co. near Dallas, Texas. All are X-band antennas.

While the parabolascope has proven its value on these past projects, the company indicated that it is continuing its efforts to evolve other measurement systems to align and check paraboloidal reflector surfaces. The next goal is development of a system to measure surface accuracy relative to the mechanical axis of a dish at any reflector attitude.

The various systems currently in use have been evaluated and studies made to optimize them for possible future use, should conditions on a particular project so warrant. Theodolites in particular, developers believe, show promise if the method of positioning targets is rigidly controlled and other principles used in present system are employed. ■



Said Pierre de Fermat:

"The optical length of an actual ray between any two points is shorter than the optical length of any other curve which joins these points and which lies in a certain regular neighborhood of it."

The continuing requirements of space exploration projects for larger and more accurate antennas have resulted in the construction of a number of enormous parabolic reflector antennas. Each costs many millions of dollars. This tremendous expense is due to the difficulty of maintaining reflector accuracy as the huge structures are moved and tilted, and as wind forces and temperature changes distort the surface.

Lockheed Missiles & Space Company's Electromagnetic organization is developing a far more economical and practical solution to the problem. A 120' reflector antenna working model now is being erected. Its shape is spherical instead of parabolic, and it is firmly mounted on the ground. *Only the feed is moved to change the beam angle.* This type of antenna design now is feasible, thanks to successful Lockheed research in spherical aberration correction. The concept should find applications in radar systems, satellite communication systems, and systems for data reception from deep space exploration probes.

Many comparable scientific break-throughs are being evolved at Lockheed because scientists and engineers find here the creative freedom needed to pursue and perfect original ideas. Lockheed Missiles & Space Company is located on the beautiful San Francisco Peninsula in Sunnyvale and Palo Alto. If you are interested in correlating your specialty to one of Lockheed's many challenging assignments, please write: Research & Development Staff, Dept. M-39C, 599 North Mathilda Avenue, Sunnyvale, California. Lockheed is an equal opportunity employer.

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Computer-ComSat Network Nearer

IBM demonstration of 20-million-bit/sec. TV rate could be a first step toward economical communications

by Michael Getler

NEW YORK—Communication satellites with high-quality TV links should play a major role in development of very rapid and economical long-range computer-communications networks for industry.

A significant early step toward integrating high-speed, high-capacity computer systems with common-carrier communication lines came last month when IBM scientists transmitted data at 20 million bits/sec. over a single high-quality TV channel in an experimental 40-mile closed-loop ground system (M/R, Dec. 24, 1962, p. 23).

Scientists are not certain just what maximum range can be achieved for a 20-megabit rate using current ground-based microwave relays, but with availability of communications satellites with the required 5-6-mc bandwidth, IBM officials are confident this extremely rapid transmission rate, equivalent to roughly 33 million words per minute, could be extended cross-country and even globally.

Though optimistic over the experiment, IBM officials emphasized that considerable work must be done in developing information sources and terminal devices able to handle and absorb data traveling at these speeds.

P. W. Knaplung, general manager of IBM's Advanced Systems Development Div. in Yorktown Heights, N.Y., pointed to line multiplexing, character assembly, switching and buffering problems which require new types of information-processing equipment.

Dr. Emil Hopner, computer communications manager of the division and leader in the development of the new experimental system, said he thought most of the technology to deal with these problems was in being, but that the devices just had not been made commercially available.

• **New concepts needed**—Knaplund and Hopner both pointed to the "important requirement for control programs to govern overall handling of information in a system, and for new concepts in total system design that will really take advantage of the great potential of available communications networks."



DR. EMIL HOPNER, computer communications manager of IBM's Advanced Systems Development Div., shown with firm's experimental TV unit.

The great economy of this type of computer-communications network, Hopner stressed, can only be achieved if all the high-speed terminal devices are developed and made available, computers can be programed to divest themselves of huge data flows in a matter of seconds, and TV time—also measured in seconds—can be bought.

Commenting on the reliability inherent in the type of experimental system which IBM demonstrated, Knaplund said "we have given considerable attention to problems of error and noise control, and development of error detection and correction and noise suppression methods. As a result of this work, we believe reliability can be achieved by relatively simple means."

The entire solid-state computer-TV channel transmit-and-receive package involves only 40 transistors, Hopner reported, and was shown to be extremely simple, lightweight and apparently low-cost.

Two significant characteristics of high-quality TV channels make them very applicable to high-speed data transmission in comparison with other current communication lines: the generally broad bandwidth associated with TV, and the basic carrier design which is engineered to transmit pulses that are similar to binary computer language symbols. Because of this, Hopner points out, relatively simple equipment can be used to translate signals between the computers and TV channels.

• **Two-channel system** — At the transmitting end of the IBM set-up is a single four-level encoder which translates the output from an experimental 20-megabit word source. At the receiving end is a clock-derivation circuit to determine sampling time, a decoder and feedback circuitry for d-c restoration.

IBM says the theoretical speed limit for binary signal transmission over a 5-mc TV bandwidth is 10 megabits per sec. To get to 20 megabits, both in theory and in reality, as later proved by the TV demonstration, IBM imposed a second channel on the same common

carrier (actual BW was reportedly between 5-6-mc and achieved the 20-megabit figure with no reported loss over the relatively short range TV net.

This was accomplished by encoding one channel so that the signal polarity would reflect the binary data, and by using the amplitude of the other channel, independent of polarity, as the second information carrier. Hopner claims that with this arrangement, noise becomes the only limiting factor, and that none was apparent over the short distance. Longer-range communications using a series of ground relays would no doubt cut down on the data rate. No extrapolation has been made at this point concerning degradation vs. distance and number of relays.

If the IBM system is to work, the equipment must be capable of handling both sine waves and steady-state conditions. Since TV cannot handle transmission of steady-state d-c without restoration circuits, IBM had to recombine receiver output signals in a feedback circuit at the receiver to reconstruct original d-c steady-state transmissions. At the 20-megabit rate, Hopner reported "no noticeable degradation of the reconstructed signal."

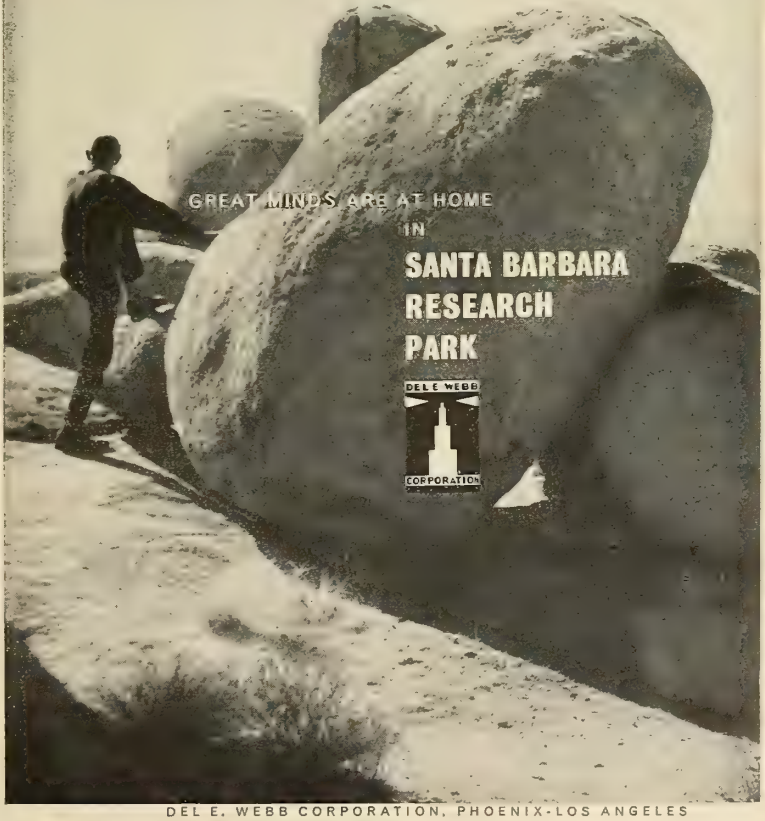
Present magnetic-tape-to-magnetic-tape data transmission rates via various broadband microwave links are on the order of 1-2 megabits, according to IBM. However, Dr. Hopner points out that this rate is perhaps inhibited as much by the limited speed of terminal devices as by the transmission medium.

• **Telephone carriers**—In addition to the TV experiment, IBM also reported first successful data transmission at 8000 bits/sec. over high-quality telephone lines. Though these speeds are considerably slower than the TV rate, IBM reports, their achievement over telephone lines was actually far more difficult due to inherent narrow-band carrier design problems. They pose greater equipment problems (both modulators and demodulators are required), and, in that respect, may prove less economical.

The telephone link also employs dual-channel polarity and amplitude carriers plus a vestigial sideband phase-modulation system, which, IBM asserts, almost doubles the capacity of the voice channel. Also very significant is an automatic waveform correction system the firm has developed to compensate for typical telephone line delay distortion. Rapid sampling of a trial signal to determine its distortion results in production of a pre-distorted waveform that will compensate for phase and amplitude distortion of the line. IBM reports that the entire automatic compensation operation takes about 1 sec. ❖

how to move a mountain

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soviet affairs

By Dr. Albert Parry

Radio Contact with Mars-I . . .

is an extremely delicate matter, says Professor Vladimir I. Siforov, a corresponding member of the Academy of Sciences and author of the well-known book *Radio-Receiving Installations* (first published in 1939; numerous editions since then). In an interview in *Izvestia* he offers this analogy: "Imagine an eccentric fellow who, having poured a glass of boiling water into the Pacific Ocean, and having stirred that particular spot well, is now trying to measure the degree to which his glass of boiling water has increased the temperature of the ocean water. Quite a task! But electronics, now aiding our astronomy, can solve tasks even more difficult than that eccentric fellow may be setting for himself in the Pacific. . . . For us to receive the signals from our *Mars-I* is much harder than for him to measure the ocean's temperature after adding that glass of boiling water. Yet we receive these signals clearly."

Psychological training of cosmonauts . . .

holds practical lessons also for the conditioning of Soviet rocket troops. A lengthy article in *Krasnaya Zvezda* by A. Stoliarenko, a naval captain, deals with the desirability of applying the methods of cosmonauts' psychological preparation to the business of improving the performance of Red missile men. Stoliarenko declares that "the training systems for the warrior-specialists will doubtless be simpler. They will not call for any expensive or complex equipment." But the main principles of such methods and machines can be used, the author maintains, to safeguard the USSR's rocket units from mistakes of judgment or lapses of endurance rooted in the men's psyches.

Rare-earth metallic elements . . .

are the subject of a new book recently issued in Moscow. *The Economics of Rare Earths* by B. I. Kogan, published by the Academy of Sciences, which covers in detail 17 rare-earth elements of particular significance to the space-and-nuclear age, among them such seldom-mentioned materials as cerium, gadolinium, europium, praseodymium, neodymium, samarium, and prometheum. The Soviet Union's chief deposits of rare-earth metallic elements are found in the Kola Peninsula, Eastern Kazakhstan, the Urals, the Ukraine, and the Trans-Baikal region.

Titanium is not economically used . . .

at some Soviet plants, complains G. Nikolayev, a staff member of a Moscow research institute, in an article in *Izvestia*. He points out that while the main problem of production and use of titanium in the Soviet Union has been solved, the side issue of what to do with by-products of this important metallic element is still neglected. The by-products should be re-processed, but no Soviet industrial office has been entrusted with this vital work. The result is that some plants, not knowing what to do with their titanium residue, send trucks loaded with it to dumping places—at night, stealthily. Other plants try to store such titanium residue, waiting for some higher authority to take it off their hands. The Moscow City Council of People's Economy expects that its factories will have some 300 tons of titanium residue in their yards. Nikolayev exclaims: "And this is while a mere kilogram of titanium residue is worth 4½ rubles!" (The ruble is officially valued by the Soviet government at $1.11.)

Glass stronger than steel . . .

and lighter than aluminum is announced as the latest product of the Scientific-Research Institute of Glass in Moscow. Its makers call it "citall." They claim it has a variety of qualities, including high heat-resistance and acid-resistance, which will make it a boon for Soviet rocketry.



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The Industry Week

AIA Review & Forecasts

Aerospace industry sales will continue to be high during 1963, possibly reaching $16 billion, according to an Aerospace Industry Association report reviewing industry trends in 1962 and estimating the prospects for 1963. The AIA report also estimates that sales of aerospace products in 1962 were about $15.5 billion.

Earnings in 1962 for 51 companies identified by SEC as aerospace manufacturers are expected to increase $93 million, to a total of $350 million, AIA said.

Despite the improvement in net profit after taxes, average 1962 net profit as a percentage of sales continued to be on the order of 2½%, as compared to a 4½% estimated average for all manufacturing industries. During the first two quarters of 1962, the industry was retaining more than 60% of its earnings after taxes for reinvestment in essential facilities and R&D programs.

The backlog of unfilled orders for aerospace manufacturers continued to decline in the first two quarters of last year. Certain missile/space program work was about the only aspect of the industry in which the backlog decline was considered relatively mild, and backlog for non-aircraft military products offset decline in orders for military craft.

The steady decline in aerospace employment in the past several years leveled out in 1961 at 668,900; jumped to 718,000 by September, 1962; and is continuing to rise, AIA says. Average 1962 employment may exceed 700,000.

Average weekly wages for missile/space industry production workers in 1961 were $115.09; by September, 1962, the figure had climbed to $118.82. In addition to wages, the average employee's various fringe benefits reached more than 55 cents per hour, AIA reports.

The association found it difficult to forecast the 1963 level of missile/space industry activity, as some 85% of the work is performed for the government. But AIA did predict that expenditures for all products provided by the industry will remain about the same as in 1962, with space spending to increase steadily.

AIAA Directors Named

The American Institute of Aeronautics and Astronautics has filled the last two openings on its board of directors. Dr. Robert W. Bussard, staff advisor of Space Technology Laboratories, will serve on the board for one year; and Martin Goland, president of Southwest Research Institute, will serve for a two-year period.

According to members of the Institute's executive committee, the two contests were so close that winners could not be determined until the final day of balloting. With election of Goland and Bussard, the 24-man board was finally completed.

In addition to the election results, it was also announced that the Institute's new systems engineering publication will be named "Astronautics and Aerospace Engineering," rather than "Astronautics and Aeronautics" as previously indicated. The first issue of the publication will appear in February, shortly after the Institute formally begins operations.

Defense Contracting Trends

California continued to head the "top-ten" list of states receiving the most military prime contract awards through the first quarter of FY 1963. New York was second, New Jersey third. The states following on the list—in order of contract totals—include: Washington, Texas, Florida, Georgia, Ohio, Pennsylvania and Massachusetts.

Monetary ranking of these contracts also found the Golden State leading the rest, with $1,304,037,000, or 26.8%. The other nine leaders were: N.Y., $377,121,000 (7.8%); N.J., $309,276,000 (6.4%); Wash., $274,135,000 (5.6%); Texas, $271,496,000 (5.6%); Fla., $188,821,000 (3.9%); Ga., $169,400,000 (3.5%); Ohio, $168,514,000 (3.5%); Pa., $167,545,000 (3.4%); and Mass., $142,764,000 (2.9%). . . . *Deputy Secretary of Defense Roswell Gilpatric has cited a shift in the nation's defense needs as a factor in the sharp decrease in prime contract awards to Midwest firms. Gilpatric commented on the decline at Grand Rapids recently, while participating in ceremonies to dedicate the Lear Siegler Aerospace Development Center. In his address, he noted that Michigan's share of prime contract awards—about 10% of the national total in World War II—had declined to only 5% by 1962.*

Gilpatric said that half of the prime military contract buys during WW II and the Korean conflict were for tanks, automotive vehicles, ammunition and other equipment for ground forces and tactical warfare. By 1961, these items made up only one-eighth of military hard goods purchases, he pointed out, while missiles grew from only 0.5% 10 years ago to about 35% of the total today. One of the largest areas of defense contracting in which the Midwest has fallen seriously behind, Gilpatric charged, is research, development, test and evaluation, which may require many more funds than are needed for production. "It is not surprising, therefore," the deputy secretary said, "that research and development awards to industry are heavily concentrated today in those areas where . . . production has grown up"—the East and West. Gilpatric stressed DOD's concern with optimum distribution of the defense industrial base; but he noted that these contract awards must always be based on merit.

Bendix Sun Sensor Is Highly Accurate

AN ATTITUDE-STABILIZATION device capable of indicating the center of the Sun to 1.0 arc seconds is being perfected by Eclipse-Pioneer Div., The Bendix Corp.

The Bendix fine sun sensor is designed for space applications lasting up to one year. It embodies allowances for changes in the Sun's distance and aging of the photosensors—without affecting accuracy.

The instrument's non d-c operation minimizes drift and eliminates all electrical bias errors, providing long-term stability. There is no cross-axis coupling on either of its two channels that would affect gain or pointing accuracy.

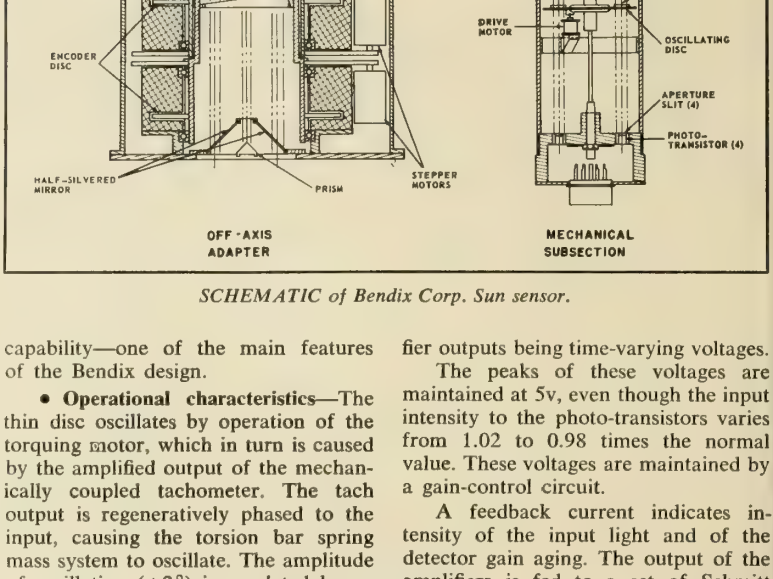
• **Design details**—The unit is body-mounted and detects along two axes—pitch and yaw or zenith and azimuth. The operation of each axis is the same: each produces two pulses, which, through phase displacement, are used to determine deviation error.

The Sun sensor has three major subsections—mechanical, electronic and optical. The mechanical subsection consists of four lenses 90° apart on the periphery of a thin disc. The disc is suspended on a torsion wire.

Also mounted on the disc are the drive-motor armatures and a tachometer. Below the disc, and in the focal plane of the lenses, are four photo-transistors mounted behind slit-shaped stops.

The second subsection covers the drive electronics and all the electronics needed to interpret the outputs from the mechanical subsection. The last subsection is an off-axis adapter—essentially an optical gimbal designed to meet a particular specification of the National Aeronautics and Space Administration. The adapter incorporates a pair of optical wedges driven separately by digital stepper motors.

An optical encoder for angular position readout is attached to each wedge. A digital servo positions each wedge so that incoming light is deviated for off-axis pointing of the spacecraft. This produces an error signal that can be used by the control system for repositioning the body-mounted sensor to obtain the desired off-axis pointing. These adapters can be designed for other than off-axis pointing capability—one of the main features of the Bendix design.



SCHEMATIC of Bendix Corp. Sun sensor.

• **Operational characteristics**—The thin disc oscillates by operation of the torquing motor, which in turn is caused by the amplified output of the mechanically coupled tachometer. The tach output is regeneratively phased to the input, causing the torsion bar spring mass system to oscillate. The amplitude of oscillation (±2°) is regulated by an automatic gain-control circuit in the drive amplifier. The frequency of oscillation is maintained at 35 cps, ±0.1%.

Light from the Sun passing directly through an aperture or through an offset device impinges on the lens in the thin, oscillating disc. As the disc oscillates and the lenses move, the four images oscillate in the focal plane—each crossing a slit-shaped stop and a photo-transistor to produce four electrical outputs—two for each axis, zenith and azimuth.

Since the lenses are physically located on one oscillating disc, the motions of the images are synchronized. Each pair of outputs is used through phase displacement to determine the deviation error for a particular axis.

Error readout is processed through associated electronics. An "arm" pulse is generated at the peak amplitude of the oscillating disc. This pulse acts as a synchronizing reference to maintain the proper sequence of succeeding operations. The output from each of the photo-transistors is amplified, the amplifier outputs being time-varying voltages.

The peaks of these voltages are maintained at 5v, even though the input intensity to the photo-transistors varies from 1.02 to 0.98 times the normal value. These voltages are maintained by a gain-control circuit.

A feedback current indicates intensity of the input light and of the detector gain aging. The output of the amplifiers is fed to a set of Schmitt triggers, which produce a step when the proper input voltage is reached.

These trigger pulses are the threshold detection of the sensor. After shaping with Schmitt triggers, the output goes into a logic circuit in the electronic subsection. The output of this is a start-and-stop pulse that can be used to gate a high-frequency clock. An additional flip-flop produces a sign bit. The sensor output is digital-serial.

The number of bits per burst is proportional to the angular error (over small angles). The burst rate is the same frequency as that of the disc.

The Bendix unit uses state-of-the-art techniques. Its weight—excluding the counter but including the electronics—is 4 lbs. Power without off-axis servo drive is 3 watts, and 7 watts with the drive. Its scan frequency is 35 ±0.035 cps, and the clock frequency is 1.6+ megacycles. The scale factor around null is 1.33 microseconds/arc second. The entire sensor is 6 in. long, 2 in. in diameter. ‡

Circle No. 225 on Subscriber Service Card

Impedance Bridge

Delta Electronics, Inc., is marketing the Model OIB-1 operating impedance bridge. This device can be connected in an active RF circuit, handling power up to 5 kw. The dials are calibrated directly in resistance and reactance-frequency units. The bridge is particularly useful in adjusting multi-element antenna systems, where the insertion of a conventional bridge would upset the circuit. The insertion effect of the bridge is equivalent to 9 in. of 150-ohm transmission line. It may also be used for measuring any power sensitive or non-linear load whose impedance is a function of its environment or operating power.

Circle No. 226 on Subscriber Service Card

Data Insertion Converter

Defense Electronics, Inc., has available the DEI Model DIC-1 data insertion converter, a modular type unit containing 20 plug-in module voltage-controlled oscillators, with three mixing amplifiers to record timing, voice and d-c or low-frequency data using FM multiplexing. The device may also be used as an FM/FM simulator or ground-station calibration unit. Subcarrier oscillator modules are available for IRIG bands one through 18, and A through E, and special band edge FSK modules are available for use with digital input signals. Multi-frequency crystal controlled modules and an auxiliary switching unit are also available for adapting the DIC-1 for use as an automatic discriminator calibrator.

Circle No. 227 on Subscriber Service Card

Subminiature Crystal Filter

A sub-miniature precision crystal filter has been developed by Hughes Aircraft Co. for use in radar, communications, and missile-guidance systems. The Micro-X uses new S-L cut crystals and a unique subminiature transformer, also developed by Hughes, to achieve true miniaturization. The overall filter package is only one-fourth the size of that possible with the older technology. The unit is packaged entirely within a standard HC-6/U crystal container with its height dimension increased only 0.14 in.

Circle No. 228 on Subscriber Service Card

Synchronous Motors

Kearfott Div. of General Precision Aerospace has developed size 15 synchronous motors widely used in recording and timing devices. These hysteresis synchronous units can be used in any applications requiring constant speed despite load or line voltage variations. Both 60- and 400-cycle units having 115v excitation are available. These



motors are 2-phase units weighing 7.5 oz. They operate in an ambient temperature range of −54° to 125°C. A typical motor, the CTO 0174 002, has a 12,000-rpm synchronous speed, 1.7 in./oz. stall torque, 0.98 in./oz. pull-out torque, and 0.92 in./oz. pull-in torque.

Circle No. 229 on Subscriber Service Card

Miniature Tachometers

Type 21-12M Digitak, TM, miniature optical shaft position encoders and pulse tachometers are available from the Wayne-George Corp. The analog-to-digital transducers are manufactured in a size 15 synchro mount with up to 4096 counts per revolution. Models are available with single direction or bi-directional counting and with zero reset. Output is 100 mv minimum into a 10,000-ohm load.

The device features high performance in stable platforms and in machine tool motion control under conditions of shock, vibration and elevated temperatures. The optical techniques used eliminate contacting surfaces such as brushes, and provide for an extremely long life. The lamps used are rated at 50,000 hours (MTBF) continuous operation.

Circle No. 230 on Subscriber Service Card

Phase Shifter

A millimeter ferrite phase shifter operating over the frequency range from 58 to 62 gc is available from Ferrotec, Inc. Model P-148L, features a minimum phase sift of 0-180°, insertion loss of 1.5 db, and a maximum VSWR of 1.25, and is designed for use in RG-98-U waveguide transmission systems, with connectors that mate with UG-385/U.

Circle No. 231 on Subscriber Service Card

Isodrive Core

An isodrive ferrite memory core in the 30-mil size for use in coincident current memories has been developed by Electronic Memories, Inc. The unit core can be operated over a temperature range of −65°C to 100°C without compensation. It is suited for use in satellite applications.

Circle No. 232 on Subscriber Service Card

New Product of the week:
First 1.0 Microsecond Memory

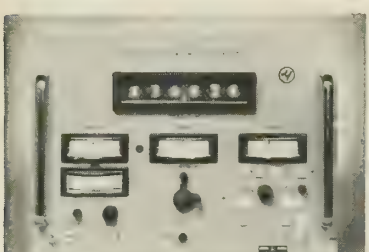
The first large-capacity ferrite core memory capable of performing a complete memory cycle in one microsecond is available from Ampex Corp.

Designated the Model LZ, the memory stores twice as much data in half as much space as the previous leader in the large-memory field, the 1.5 microsecond Ampex LQ. The unit meets the data-processing industry's increasing demand for faster and larger-capacity storage units. Like the LQ, the LZ is completely compatible with current computers for data-processing and control applications. The LZ has a storage capacity of 4096 to 16,384 words with word lengths of 18 to 72 bits. Its operational modes are "read-restore" and "clear-write." Its control signals are "read-request" and "write-request." Along with its complete cycle time of one microsecond, its read access is 0.5 microseconds after read-request.

Circle No. 233 on Subscriber Service Card



FM Signal Generator



Providing frequencies accurate to 0.0003%, Microdot's Model 412 operates in the 400-550 mc range with direct digital readout to 1 kc. Single-knob tuning permits continuous frequency coverage, fast setting and frequency search capability. Lighted push-button controls and 6-digit readout minimize human error and permit instantaneous output interpretation. Only 13 x 19 x 18 inches, unit is no larger than average of the five major components of less versatile generators. 95% solid-state.

Circle No. 8 on Subscriber Service Card

VHF-UHF Power Oscillators



This complete line of precision units offers frequency ranges of 10 to 1050 mc with single-knob tuning. High power (50 watts), extremely constant output and highly accurate frequency control makes these units invaluable in research and development of rf equipment. Power supplies are regulated to 1%, conservatively rated components are carefully arranged for long life, easy inspection. Typical unit measures 8" x 11½" x 19"; weighs 45 lbs. Adaptable to rack mount.

MICRODOT INC.

220 Pasadena Avenue
South Pasadena, California

Overseas: MICRODOT AG, Zug, Switz.

Circle No. 9 on Subscriber Service Card

Automation System

A complete "off-the-shelf" Presto industrial automation system for automatic control of up to four integrated production operations has been developed by Bogen Communications Division of Lear Siegler, Inc.

Included in the basic system are three instrumentation tape transports with provision for a fourth, a preselective random programmer and a specially designed preamplifier.

The system features maximum reliability. It has a 36-hour operation cycle, is factory-wired and adjusted in semi or full automation models.

Circle No. 234 on Subscriber Service Card

Ionization Gage

A high-vacuum ionization gage, the GIC-110A, is now available from Consolidated Vacuum Corp., a subsidiary of Bell & Howell.

The gage measures pressures in the 2×10^{-9} to 1×10^{-3} torr range on a linear decade meter scale. It has built-in adjustable filament protection and alarm circuit. Thermal overload protection is provided and there is automatic filament-emission control. Terminals with an output of 11 millivolts d-c are available for connecting a recorder. A plug-in thermocouple accessory extends the upper limits of the pressure range to 2 torr.

The GIC-110A is designed for use with CVC's GIC-015, -016, and -017 ionization tubes, but can also be used with other commerically available tubes.

Circle No. 235 on Subscriber Service Card

Direct Counting Converter

An all-solid-state device for extending the frequency range of electronic counters to 100 megacycles with 10 cps resolution has been developed by Computer Measurements Co. The CMC Model 740A consists of a 100 mc octade prescaler which includes the input amplifier and shaper, an octade time base divider and self-contained power supply. Used in conjunction with an electronic counter having a frequency ratio (A/B) function and a frequency range of 12.5 mc or better, the unit will provide direct digital readout (on the counter) of any unknown frequency to 100 mc.

For use with counters of lower frequency ranges, it has provision for extending the normal scaling factor of 8 to 80 or 800 if desired. With a prescaling factor of 80 on the Model 740A, a



1.25 mc counter could measure frequencies to 100 mc with a 100 cps resolution.

Circle No. 236 on Subscriber Service Card

Pulse Forming Network

Exposure time ranges for nanosecond Kerr cell modulators can be greatly extended as a result of two newly expanded product lines of voltage pulse forming networks available from Electro-Optical Instruments, Inc.

This extended pulsing network product line provides one Kerr cell instrument system with a potential range of exposure times from five nanoseconds to twenty microseconds. Prior to this time EOI Kerr cell modulators had available only the exposure time incorporated in the original devices.

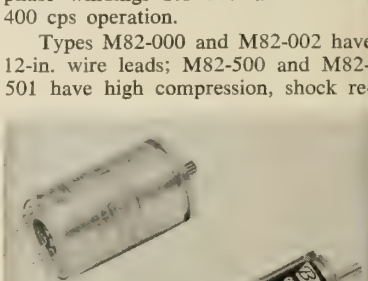
Designated model PFN and PFNT, these pulsing networks are rapidly interchangeable in all EOI Kerr cell camera and laser modulation systems already in the field. Although packaged for high voltage, they are compact in size.

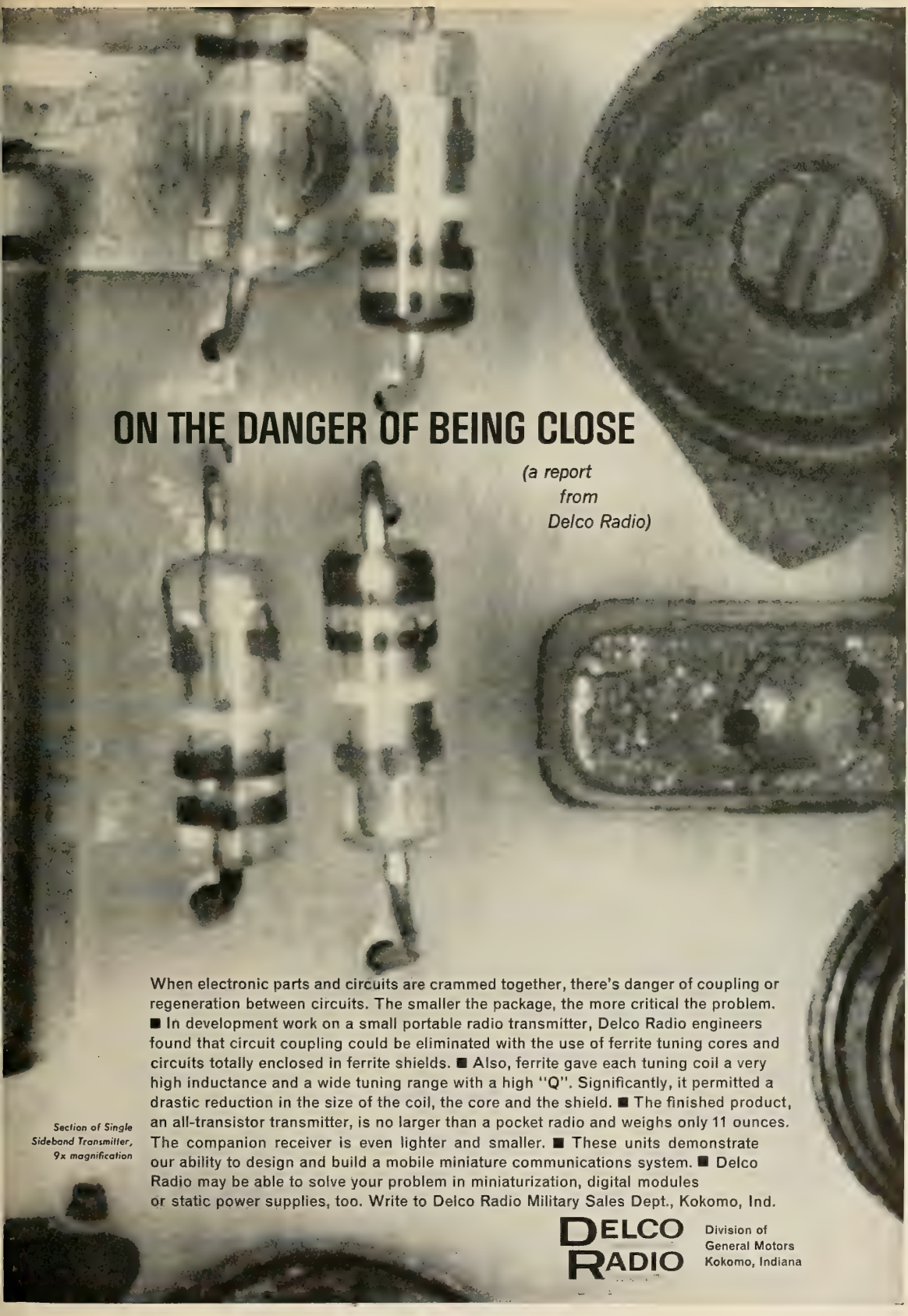
Circle No. 237 on Subscriber Service Card

Servo Motors

Developed by Bomar Instrument Corp., a series of four size 8 servo motors has 115-volt fixed phase winding and plain or centertapped control phase windings for 115 and 36-volt, 400 cps operation.

Types M82-000 and M82-002 have 12-in. wire leads; M82-500 and M82-501 have high compression, shock re-





ON THE DANGER OF BEING CLOSE

(a report from Delco Radio)

When electronic parts and circuits are crammed together, there's danger of coupling or regeneration between circuits. The smaller the package, the more critical the problem. ■ In development work on a small portable radio transmitter, Delco Radio engineers found that circuit coupling could be eliminated with the use of ferrite tuning cores and circuits totally enclosed in ferrite shields. ■ Also, ferrite gave each tuning coil a very high inductance and a wide tuning range with a high "Q". Significantly, it permitted a drastic reduction in the size of the coil, the core and the shield. ■ The finished product, an all-transistor transmitter, is no larger than a pocket radio and weighs only 11 ounces. The companion receiver is even lighter and smaller. ■ These units demonstrate our ability to design and build a mobile miniature communications system. ■ Delco Radio may be able to solve your problem in miniaturization, digital modules or static power supplies, too. Write to Delco Radio Military Sales Dept., Kokomo, Ind.

Section of Single Sideband Transmitter, 9x magnification

DELCO RADIO

Division of General Motors Kokomo, Indiana

Circle No. 2 on Subscriber Service Card

sistant glass-molded terminals with internal connections secured by high temperature solder, and low rotor inertia of 0.27 Gm-Cm² is a principal operating characteristic of all four types.

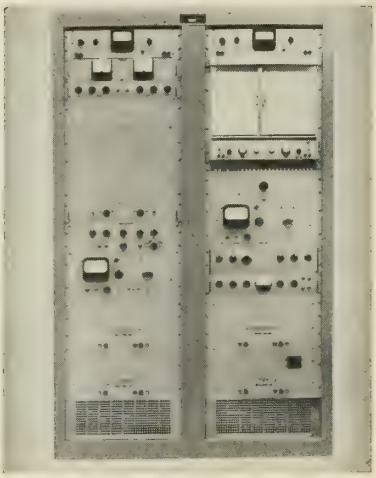
No-load motor speeds are given at 6000 rpm, and all four types are available individually or assembled to matched Bomar servo gearheads having ratios from 7:1 to 2000:1. No-load output speeds of the motor-gearhead combinations range from 3 to 787 rpm.

Circle No. 238 on Subscriber Service Card

Ratio Analyzer

A transmissibility ratio analyzer and plotter, providing an economical method for quick data processing, has been developed by Gulton Industries, Inc. Applications are found in the aeronautical field, servo checkout work, vibrational testing and structural analysis.

The Model OTP-1 provides a ratio between excitation and response of specimens in a vibration test set-up. An important feature of the instrument is its effective operation using the random signals that are often applied in practical testing. It does not require the sinusoidal or periodic signals obtainable



only under carefully controlled laboratory conditions. As an additional feature, the analyzer eliminates the need for complete driver equalization in mechanical structure analysis.

Circle No. 239 on Subscriber Service Card

Neodymium for Lasers

Hayward Scientific Glass Corp. has developed neodymium doped glass (LN-2) for solid-state laser applications.

Gas bubbles, striae, strain, chemical inhomogeneity and other imperfections common to popular crystal materials are relatively non-existent in LN-2, affording the designer an infinitely higher degree of system efficiency.

Specifications for the new Hayward LN-2 laser glass include thresholds as low as 20 joules at room temperatures, using an elliptical cavity system with a linear flash lamp. Absorption occurs at 5800 angstroms with an output frequency of 1.06 microns. Lifetime (decay time) is approximately .45 milliseconds.

Circle No. 240 on Subscriber Service Card

Photographic Recorder

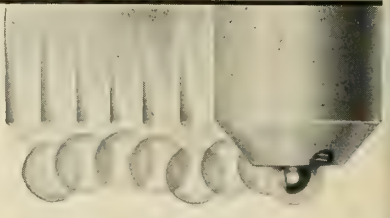
Available from Dallons Lab. Inc. and designed for photographic recording of physical parameters in aeronautics and missiles, as well as for fast phenomena in the electrical and electronic industries, the Dallons-Telco 8-channel photographic recorder Model EP82 will record from 1 to 8 phenomena on 5-in. wide photographic paper with very high, constant clarity. The unit features up to 8 mirror-galvanometers, permitting full crossover of tracings.

The Model EP82 is designed to accept standard 120 mm wide unperfo-



The first TRULY FRICTIONLESS Gage Head

CLEVELAND CARTRIDGE TRANSDUCER



NO HYSTERESIS

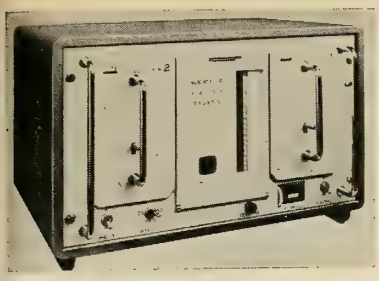
Tiny (3/8" O. D. x 2-3/16" long) . . . accurate, the 3/8" Cartridge Transducer is a new concept for electronic gaging in limited access areas! It is specifically designed to replace less accurate dial indicators and air gages. The reed spring internal mounting design eliminates all frictional and mechanical hysteresis, and, this quality precision Cleveland gage head can be used with common gaging fixtures such as snap gages and bore gages. By this means, more accurate repeatable readings to millionths of an inch are obtained.

The Cartridge Transducer is rugged enough to be used as a working machine gage, or in the final inspection of parts.

Check CLEVELAND for:
DIMENSIONAL GAGES
SURFACE FINISH GAGES
ROUNDNESS GAGES

Cleveland INSTRUMENT COMPANY
A SUBSIDIARY OF THE BENDIX CORPORATION
6220 EAST SCHAAF ROAD • CLEVELAND 31, OHIO

Circle No. 11 on Subscriber Service Card



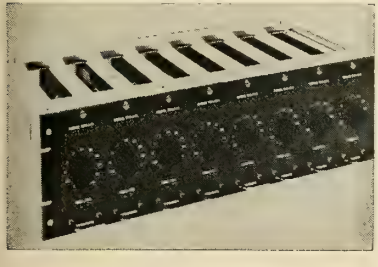
rated Kodak photographic paper, and operate at 25 or 50 mm per second, with electrical switching and braking. It permits direct visualization of trace position during recording. Horizontal and vertical ordinates are optically and simultaneously photographed with traces.

Circle No. 241 on Subscriber Service Card

Tape Recorder Amplifier

Providing amplification between 1 and 100 to signals which range from d-c to 200 kc, a modular instrumentation tape recorder amplifier is available from Astrodata Inc. The all-transistorized, adjustable-gain Model TPA-141 is especially designed for use in coupling medium-level signal sources to tape recorders, FM subcarrier oscillators, strip chart recorders and other instrumentation.

Eleven gain steps may be selected



by front panel switch. Gain accuracy is ±1% at d-c; gain stability, ±0.1% for three months. Input resistance is greater than 100,000 ohms; output resistance less than 50 ohms.

Circle No. 242 on Subscriber Service Card

Hygrometer Recorder

A versatile humidity monitoring recorder is offered by Hygrodynamics, Inc., for industrial and scientific applications. The recorder is a semi-portable, compact unit that can provide continuous monitoring of humidity and temperature conditions for up to 10 days, or it can be used for on-spot checking at any location where 115v, 60-cycle power is available.

The two-trace, strip chart recorder monitors humidity and temperature, or two humidities or two temperatures, when used with Hygrodynamics' pre-

HOW MUCH CAN A SCIENTIST DO FOR HIS COUNTRY?

At MITRE engineers and scientists are working to create the command and control systems that protect our country from attack. This is a job of global scope and national importance.

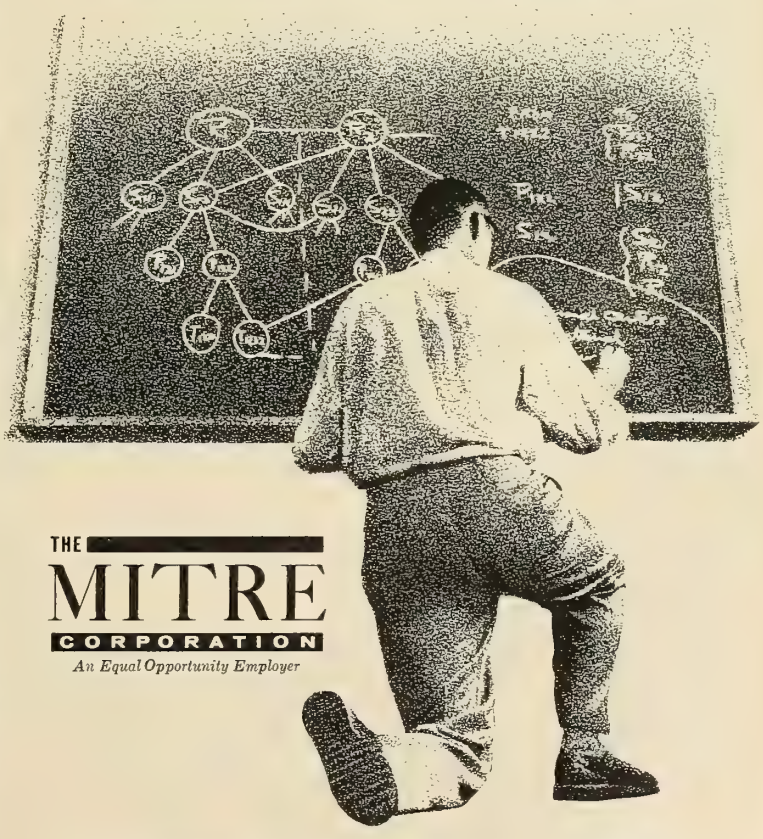
You know some of these systems by name — SAGE, BMEWS, NORAD Combat Operations Center. Here is an opportunity for you to become intimately acquainted with their design, development and integration. And perhaps most important — to help in the creation of systems yet unnamed.

Your work at MITRE would lead you into new areas of work — spawned by the growing new science, Military Command Technology. You might be developing survivability techniques, or processing intelligence data with one of the world's largest computers, or designing new systems for tracking space hardware.

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MITRE, an independent nonprofit corporation, working with — not in competition with — industry, serves as technical advisor to the Air Force Electronic Systems Division, and is chartered to work for such other Government agencies as the Federal Aviation Agency.

cision humidity-temperature sensors.

It is for inspection of conditioned spaces, work areas, storage rooms, and other applications where material in process or storage is hygroscopic and thus is affected adversely by improper humidity conditions.

Circle No. 243 on Subscriber Service Card

Miniature Noise Chopper

United States Energy Corp., a subsidiary of Talon, Inc. has developed a d-c/a-c chopper. Talon 70A operates



from a 20-200 cps 6v drive source throughout a temperature range of −65°C to 125C° and maintains a sub-micro volt noise level in low impedance circuits. Contacts are arranged for SUDT and are rated at 1 ma at 10v. Coil resistance is approximately 285 ohms. The armature is statically and dynamically balanced, making operation possible under severe vibration conditions. It will tolerate vibration of ½-in. displacement or 20G's throughout 5-2500 CPS.

Circle No. 244 on Subscriber Service Card

Distribution Amplifier

By expanding from 10, 12, 15, or 18-channel models, up to 21 output channels are provided from one input in the fully transistorized Model 202 standard frequency distribution amplifier available from Montronics, Inc. Excellent phase stability permits distribution of calibration frequencies to remote locations without degradation.

Features include a standard input of 100 kc, 1 v rms into 50 ohms (with 1 mc input also available) a channel output of 2 v rms into 50 ohm load, high quality silicon transistor amplifier circuitry and power requirement of 115/220 v ac, 50-400 cps, typically 15 watts.

Circle No. 245 on Subscriber Service Card

Electronic Thermometer

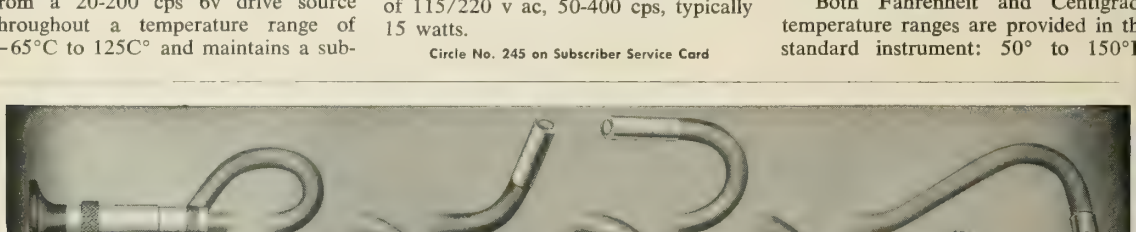
An electronic thermometer that gives a highly accurate reading of surface temperatures in from three to 10 seconds is being marketed by Electronics Research Corp.

Unit will read temperatures of any component in an electronic circuit and



will read point-to-point temperature contours of heat dissipating devices as well.

Both Fahrenheit and Centigrade temperature ranges are provided in the standard instrument: 50° to 150°F



Focusing eyepiece for convenience of user.

For the ultimate in precision viewing of intricate, hard-to-reach areas . . .

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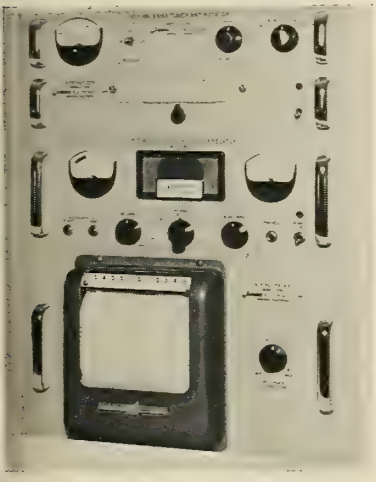
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150° to 250°F, 0° to 100°C, and 100° to 200°C. Accuracy is 1½% of scale range. Instrument is fully portable, operating from a self-contained standard transistor radio battery.

Circle No. 246 on Subscriber Service Card

VLF Frequency Correlator

A solid-state VLF frequency correlator set combining extreme accuracy with realistic economy has been developed by Interstate Electronics Corp. The device provides what amounts to an extension cord reaching from one or more extremely accurate frequency standards



directly to the user's calibration laboratory. The set receives world-wide transmissions from such stations as NBA, WWVL, and GBR, providing the ability to calibrate an oscillator to an accuracy of 0.00000003% within a few hours.

Circle No. 247 on Subscriber Service Card

Center of Gravity Locator

The Bytrex Corp. has available a center of gravity determination system that provides a simple and precise means for determining the center of gravity on a wide variety of test objects. The system measures unbalance directly in both the X-X and Y-Y axis and allows location of the center of gravity of a capacity object to within ± 0.001 in. in all axes.

Calibration of the CG Locator is simple. A known weight is placed on the detecting head at a known distance from the center, providing a precisely known unbalance.

Detecting heads of various capacity devices can be supplied to work into the same instrument. Detecting heads have a load-carrying capacity of 250, 1000, 2500 and 10,000 lbs. with unbalance ranges of ±25, ±100, ±250, and ±1000 inch-pounds respectively.

Circle No. 248 on Subscriber Service Card

Silicon Transducer

Interdigitated epitaxial planar silicon transistors are available from the Lansdale Div., Philco Corp. as the 2N2651.

The device combines the techniques of expitaxial deposition, planar structure, and gold doping with an interdigitated emitter-base configuration to provide switching rates in excess of 50 mc with beats of 60 at 25 milliamperes and 30 at 200 milliamperes.

The 2N2651 can replace 25 of the most prevalently used silicon switching transistors by virtue of having a typical gain bandwidth product (fT) of 600 mc and a storage time constant of seven nanoseconds plus high beta performance over a current range of 1 to 250 ma.

Circle No. 249 on Subscriber Service Card

Flexible Servo System

A flexible general-purpose servo system test set with digital frequency readout, designated Remanco Servodyna Model 902-D, incorporating a precision electronic function generator, suppressed carrier modulation and a high-accuracy phase-measuring device is being marketed by Remonco, Inc.

The unit enables servo engineers to completely test and evaluate an a-c servo system and to run frequency, phase and transient response tests on d-c servos.

Circle No. 250 on Subscriber Service Card

Octave Band Circulator

Developed by Western Microwave Laboratories, Inc., the Model CS-24 full octave S-band coaxial circulator with characteristics previously limited to only narrow-band devices. Over the full S-band range of 2000 to 4000 mc, the unit provides isolation greater than 20 db, insertion loss less than 0.4 db and a maximum VSWR of 1.25. Average RF power capability of the CS-24 is 50 watts.

Circle No. 251 on Subscriber Service Card

Silicon Current Regulator

Available from Semiconductor Magnetics, Inc., the Model CR5 general-purpose current regulator is a two-terminal silicon device capable of supplying constant current, at a very high impedance, when used with a voltage source. Weighing only 6 g and with a volume of 0.125 cu.in. this solid-state component lends itself to unlimited circuit applications, including power supplies, Zener diodes, Hall generators, differential amplifiers, integrators, strain gages, multivibrators, phase-shifting networks, and chopper drivers.

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Rotary Switch Modules

A line of rotary thumbwell switch modules and assemblies for converting decimal dial indication to coded electrical output is available from Engineered Electronics Co.

Made of military-quality materials

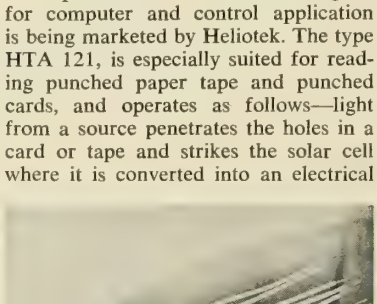


for ruggedness, the panel-type switches feature a unique detent arrangement which prevents inadvertent hand-up between positions. Rated mechanical life is 100,000 revolutions; rated electrical life, 50,000 revolutions. Characters on thumbwheels are engraved and filled for legibility and elimination of glare. Applications include computers, test equipment and ground support equipment.

Circle No. 253 on Subscriber Service Card

Photovoltaic Cell

A photovoltaic readout cell designed for computer and control application is being marketed by Heliotek. The type HTA 121, is especially suited for reading punched paper tape and punched cards, and operates as follows—light from a source penetrates the holes in a card or tape and strikes the solar cell where it is converted into an electrical



output. This output is then fed through a transistorized amplifying system which activates the computer or control mechanism.

These photovoltaic cells eliminate the need for external power supplies since they convert light energy directly into a usable electric output. As well as being self-generating, they are characterized by extremely long life and stable electrical characteristics. They feature a short response time of less than 10 microseconds.

Circle No. 254 on Subscriber Service Card

High-temperature Solenoid

High-temperature solenoids, capable of continuous operation of 400-cycle a-c power over a temperature range of −65° to 650°F, are available from Telecomputing Corp. Hermetically sealed and pressurized, they are independent of altitude conditions and operate continuously with a voltage range of 90-124 v and 380-420 cps. A diaphragm sealing system that isolates all components from contact with valve fluid except the armature is designed to withstand 5000-psi burst pressure and 3000-psi operating pressure. The solenoid exerts a minimum 5-lb. pull with 98 v, 420 cps at 550°F and 0.03 in. air gap.

Circle No. 255 on Subscriber Service Card

Flexible Waveguide

Flexible waveguide assemblies especially developed for 12 kmc communications systems are available from Airtron, a division of Litton Industries. The waveguide, which mates electrically with the WR-75 rigid waveguide, is made with either twistable or soldered construction. Standard jacketing material is molded neoprene for waveguide sections in length from six to 60 in. The assemblies are available with any combination of choke and cover flanges. Specifications include: frequency, 10.0-15.0 kmc; maximum attenuation 0.18 db/ft. at 10 kmc; midband attenuation 0.15 db/ft.; VSWR 1.10 maximum; pressure rating, 45 psig; minimum E-plane bend radius, 1⅜ in.; minimum H-plane bend radius, 2¼ in.; twist 90°/ft.

Circle No. 256 on Subscriber Service Card

One-watt Transmitter

A solid-state 1w transmitter for aerospace applications is available from Tele-Dynamics Div. of American Bosch Arma Corp. Type 1054 has been proven reliable under extremes of environmental conditions and power unit. One-watt output and electrical characteristics are maintained at temperatures up to 185°C, vibration levels of 15g, shock of 100g, and acceleration of 60g.

This crystal-stabilized FM transmitter, in two models, covers any frequency in the 215-to-260-mc telemetry band. The transmitter employs silicon transistors and is enclosed in a pressure-sealed aluminum case.

Circle No. 257 on Subscriber Service Card

AWARDS

AIR FORCE

$30,000,000—**United Aircraft Corp.,** United Technology Center, Sunnyvale, Calif., for design, development, fabrication, delivery and flight test of large segmented solid propellant motors.

$22,705,045—**Aerojet-General Corp.,** Azusa, Calif., for work on Stage II *Minuteman.*

$19,600,000—**International Telephone and Telegraph Corp.,** New York City, for operation, maintenance and support of Distant Early Warning systems at Federal Electric Corp., Paramus, N.J., and DEW sites.

$5,500,000—**Hughes Aircraft Co.,** Culver City, Calif., for research and development of a fire control system for the *Falcon* missile.

$4,200,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space vehicles for the *Agena* program for NASA.

$2,275,000—**Avco Corp.,** New York City, for work on a classified contract in Wilmington, Mass.

$1,817,708—**Sylvania Electric Products, Inc.,** New York City, for spares for electronic equipment. Work to be done in Waltham, Mass., Mountain View, Calif., and other sites.

$1,500,000—**International Telephone and Telegraph Corp.,** New York City, for ground communications system equipment for *Minuteman* facilities at Vandenberg Air Force Base.

$1,121,000—**Hallicrafters Co.,** Chicago, Ill., for electronic equipment.

$1,000,000—**Acoustica Associates, Inc.,** Los Angeles, Calif., for propellant utilization systems for the *Atlas* program.

$1,000,000—**General Dynamics Corp.,** Pomona, Calif., for *Atlas* missiles. Work to be done at San Diego, Calif.

ARMY

$19,896,130—**Western Electric Co.,** New York City, for additional research for the *Zeus* missile radar system.

$19,500,000—**General Telephone and Electronics Corp., Sylvania Electronics Systems Div.,** Needham, Mass., for work on a classified contract.

$19,300,000—**General Telephone and Electronics Corp.,** New York City, for the production of advanced electronic communications equipment.

$6,583,435—**Raytheon Co.,** Andover, Mass., for engineering services for the *Hawk* missile.

$4,715,381—**Raytheon Co.,** Lexington, Mass., for battery sets and field maintenance equipment for the *Hawk* missile system.

$4,496,760—**Bell Aerospace Corp., Bell Aerosystems Co.,** Buffalo, N.Y., for electronic equipment.

$4,240,469—**General Dynamics Corp.,** Pomona, Calif., for continued development of the *Mauler* weapon system.

$4,189,085—**General Telephone and Electronics Corp., Sylvania Electronics Systems, Div.,** Needham, Mass., for work on a classified contract.

$2,003,266—**Universal Match Corp.,** Ferguson, Mo., for 17 erector-launcher-transporters for the *Pershing* missile system.

$1,502,971—**Yardney Electric Corp.,** New York, for Silvercel silver-zinc batteries for aircraft, missiles and communications systems.

$1,398,600—**Walter Kidde and Co., Inc.,** Belleville, N.J., for rocket motors for antiaircraft target drones.

$1,087,012—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for research in connection with the development of a biological warning system.

NAVY

$8,000,000—**General Dynamics Corp.,** Pomona, Calif., for increased funding for *Terrier* and *Tartar* missile guidance control units.

$2,003,008—**General Time Corp.,** Westclox Div., LaSalle, Ill., for fuzes for the *Zuni* rocket.

$1,561,996—**Westinghouse Electric Corp.,** Baltimore, for water-velocity measuring subsystems for the *Polaris* missile equipment.

$1,531,733—**General Electric Co.,** Pittsfield, Mass., for continued work on the *Polaris* guidance system at Pittsfield.

$1,215,000—**Institute for Defense Analysis,** Washington, D.C., for classified research.

Bendix Corp.'s Pacific Div., North Hollywood, Calif., for assistance in the development and construction of a transducer-amplifier unit for the Long Range Detection Sonar System (LORAD) on the submarine USS Baya (undisclosed amount).

NASA

$7,376,379—**Electro-Mechanical Research, Inc.,** Sarasota, Fla., for manufacture, test and installation of telemetry PCM ground stations for the NASA world-wide range for tracking manned spacecraft.

$3,000,000—**International Business Machines Corp.,** Rockville, Md., for real-time computer complex.

$234,331—**North American Aviation,** Downey, Calif., for hardware specifications for *Gemini.*

$61,000—**General Dynamics Corp., General Dynamics/Convair,** San Diego, Calif., for a study of creep problems involved in SST design.

$16,475—**International Telephone and Telegraph-Kellogg,** Fort Wayne, Ind., for modification of radio homing set for Project *Mercury.*

$12,667—**Empire Device Co., Inc.,** Amsterdam, N.Y., for noise and field intensity meter, tuning unit.

$9,000—**Wyle Laboratories,** El Segundo, Calif., for *Apollo* rate gyro evaluation and testing.

$7,830—**Protection, Inc.,** Los Angeles, Calif., for prototype pressure suit.

$4,405—**Whirlpool Corp.,** St. Joseph, Mo., for urine transport measuring and sampling device.

INDUSTRY

$2,000,000—**Goodyear Aircraft Corp., Goodyear Aviation Products Div.,** Akron, Ohio, from **Hercules Powder Co.,** for rocket liners for the *Minuteman* missile.

$339,700—**General Telephone and Electronics Corp., Sylvania Electronics Systems Div.,** Needham Mass., from **General Electric Co.,** for electronic plug-in modules for the *Polaris* fire-control computer system.

$80,000—**Raytheon Co.,** Lexington, Mass., from **Boeing Co.,** for transistors for the *Minuteman* system.

Electro-Mechanical Research, Inc., Sarasota, Fla., from **McDonnell Aircraft Corp.,** for spacecraft data transmission and onboard recording systems and associated ground checkout equipment for Project *Gemini* (undisclosed amount).

National Research Corp., Cambridge Mass., from **Pratt and Whitney Aircraft Corp.,** for advanced space simulation testing of rocket engine components for the *Saturn* second stage (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Aerospace Procurement Div.
Subsystems Procurement Branch
Norton AFB, Calif.

The following is a description of engineering services in support of the SM65 *Atlas* re-entry vehicle subsystem. This procurement is for services to be procured concurrently with hardware end items. Instructions and techniques must be verified against existing data and equipment. RFP 04-607-63-284. RFP due date not furnished. Request for proposal has been furnished to: Avco Corp., 550 South Main St., Stratford, Conn. This synopsis is for subcontracting information only. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firm. Services are for a period of 6 months, utilizing approximately 4175 man hours of engineering for analysis of test data, deficiency reports, preparation of engineering changes proposals, and other specialized tasks that may be assigned to resolve problems developed in the Mark IV re-entry vehicle system. Bidders must have available all up-to-date engineering data, drawings, manuals, necessary facilities, etc.

Defense Construction Supply Center
Defense Supply Agency
52 Starling Street
Columbus, Ohio

Repair parts for *Pershing* guided missile, various federal stock numbers, various quantities, for delivery to Memphis General Depot, Memphis, Tenn. Requests for proposals have been issued to the prime manufacturer and specifically designated subcontractors.

NASA Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

Negotiations will be conducted with the Pioneer Parachute Co., 168 Forest St., Manchester, Conn., for parasail evaluation and development. RFP No. MSC-63-239P. Note: For information only. No RFP available. Firms interested in subcontracting opportunities should contact the above firm direct.

Bureau of Naval Weapons
Washington 25, D. C.

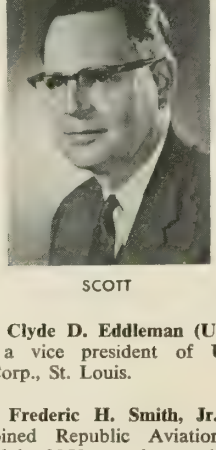
For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Vitro Laboratories, a division of Vitro Corp. of America, Silver Spring, Md., to provide services and materials necessary to conduct a research and development program on *Terrier, Tartar, Talos* and *Typhon* missile systems. Award will be made on the basis of a continuation and expansion of a research and development program previously undertaken by the above firm under an existing contract. This notice is made for information purposes only. C/N 0228-63. BuWeps Synopsis No. 122-63.

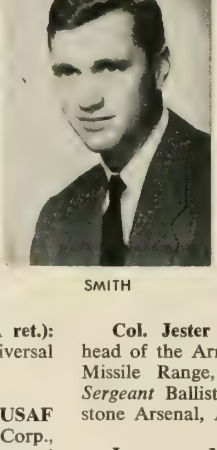
U. S. Navy Department
Bureau of Ships
Washington 25, D. C.

The Bureau of Ships under RFP 622B-31854 (S) is soliciting a proposal from Beckman Instruments, Inc., Special Products Div., 2500 Harbor Blvd., Fullerton, Calif., for the manufacture of atmosphere analyzer, Mark IV, required for training purposes—1 each. This company has the necessary knowledge and experience to manufacture this equipment which is needed for training purpose and therefore under a bureau contract. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.


KULLAS


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SMITH


LYNN

Richard C. Schaub: Appointed sales manager of Products Research Co.'s Chem-Electro Research, Inc. subsidiary, Los Angeles.

Albert J. Kullas: Appointed director of engineering for Martin Co.'s Denver Div., Denver, Colo.

Frank E. Stehlik: Appointed general controller for Baldwin-Lima-Hamilton Corp., Philadelphia.

David C. Scott: Formerly with General Electric, will join Fairbanks Whitney Corp., Hartford, Conn., as vice president and group executive.

Carl W. Chambers: Named manager-administration of the Douglas Aircraft Co.'s newly announced corporate advanced research laboratory, Huntington Beach, Calif.

Ivar A. Lundgaard: Named director of sales for Du Pont Co.'s Photo Products Dept., Wilmington, Del.

Dr. Mark K. Smith: Appointed research vice president for Geophysical Service, Inc., Dallas.

Jack E. Steinhelper: Appointed industrial relations manager of the Federal-Mogul Div. of Federal-Mogul-Bower Bearings, Inc., Detroit.

Robert H. Jerome: Douglas Missile and Space Div., elected president of the Aerospace Electrical Society for 1963.

Alvan J. Lynn: Appointed senior systems engineer at Kollsman Motor Corp., Elmhurst, N.Y.

James A. Woolf: Appointed advertising and sales promotion manager for the Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif.

Dr. Paul Kisliuk: Named head of the Quantum Electronics Dept. at Aerospace Corp., El Segundo, Calif.

Wes Wihtol: Named quality control manager of Litton Industries' Electron Tube Div., San Carlos, Calif.

Gen. Clyde D. Eddleman (USA ret.): Elected a vice president of Universal Match Corp., St. Louis.

Gen. Frederic H. Smith, Jr. (USAF ret.): Joined Republic Aviation Corp., Farmingdale, N.Y., as vice president and executive assistant to the president.

J. B. Scatchard: Named corporate controller of System Development Corp., Santa Monica, Calif. **E. F. Czichos, Jr.,** appointed contracts manager.

John T. Thompson: Elected vice president of International Telephone and Telegraph Corp., New York City.

John F. Cooney: Named vice president of industrial relations for the California Div. of Menasco Manufacturing Co., Burbank, Calif.

Jerry Lane: Appointed sales representative for the Pacific-Northwest territory for Benson-Lehner Corp., Van Nuys, Calif.

Robert B. Hutchins: Appointed director of Marketing Services of Epsco, Inc., Cambridge, Mass. **John Bragg** promoted to sales coordinator of the Systems Div.

William Davey: Appointed assistant director of manufacturing for the Aerospace/Rockets Div. of Textron's Bell Aerosystems Co., Buffalo, N.Y.

Luis W. Alvarez: Elected to the board of directors of Allied Research Associates, Inc., Concord, Mass.

Morris L. Soifert: Appointed director of engineering for Schaevita Engineering, Pennsauken, N.J.

Leon A. Patt: Appointed group vice president of the Carborundum Co. for international operations, Niagara Falls, N.Y.

Richard B. Barnard: Elected to the board of directors of Teleflex, Inc., North Wales, Pa.

Dr. C. F. Martin and **Dr. William T. Wells:** Joined the technical staff of Pan American World Airways Guided Missile Range Div. at the Atlantic Missile Range.

Col. Jester M. Loomis, Jr.: Former head of the Army element at the Atlantic Missile Range, named manager of the *Sergeant* Ballistic Missile Project at Redstone Arsenal, Ala.

Lawrence M. Limbach: Named vice president-manufacturing of Ryan Aeronautical Co., San Diego, Calif.

Peter J. Kaufmann: Appointed computer production manager for the Berkeley, Calif., division of Beckman Instruments, Inc.

Daniel C. Sweeney: Promoted to vice president of U.S. Sonics Corp., Cambridge, Mass.

Leslie F. Schurck: Formerly with Cooper Alloys Corp., joined Coast Metals, Inc., Little Ferry, N.J.

Hal A. Salzman: Appointed vice president of marketing for National Resistronics, Inc., New York City.

Harry Matthieson: Named vice president of manufacturing for the Arwood Corp., New York City.

Lt. Gen. Richard C. Lindsay (USAF ret.): Appointed assistant to the president of Electronic Communications, Inc., St. Petersburg, Fla.

John N. Boland: Appointed manager of product planning for Pickard & Burns, Inc., Waltham, Mass.

David L. Fridge: Formerly with Optics Technology, joined Electro-Optical Systems, Inc., Pasadena, Calif., as a senior physicist in the Quantum Physics Div.

Dr. P. A. Clavier: Elected vice president-director of engineering sciences at Plasmadyne Corp., Santa Ana, Calif. **J. W. Winzeler** elected vice president, components division.

Alan B. Dallas: Elected vice president field engineering at Consolidated Systems Corp., Monrovia, Calif. (correction)

Dr. Samuel Batdorf: Appointed director, office of research in Aerospace Corp.'s San Bernardino, Calif., operations.

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Michael Rouff

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R. Lenn Franke, Jr.

Dallas 24, Texas—222 Wynnewood Professional Building; WHitehall 3-4266
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Miami, Florida—P.O. Box 890, Hollywood, Fla.; WIlson 7-6072
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JANUARY

Millimeter and Submillimeter Conference, IRE, Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

American Chemical Society National Meeting, Cincinnati, Jan. 13-18.

Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Jan. 14-18.

Ninth Annual American Astronautical Society Meeting, Statler Hilton Hotel, Los Angeles, Jan. 15-17.

31st Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 21-23.

43rd Annual Meeting, American Meteorological Society, New York City, Jan. 21-24.

Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn., International Inn, Washington, D.C., Jan. 28.

12th Annual Quality Control Clinic, Minnesota Section, ASQC, Leamington Hotel, Minneapolis, Minn., Jan. 29.

Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

FEBRUARY

Symposium on Engineering for Major Scientific Progress, Georgia Institute of Technology, Atlanta, Feb. 5-6.

Electronic Sales-Marketing Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques, UNESCO Building, Paris, Feb. 11-15.

Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory, Engineers Club, Dayton, Ohio, Feb. 12-13.

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Feb. 18-19.

Conference on Crew Escape Techniques for Aerospace Vehicles, sponsored by Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson Air Force Base, Dayton, Ohio, Feb. 19-20. (Secret).

Fourth Annual Reliability Symposium, Los Angeles Section, ASQC, Statler Hilton Hotel, Los Angeles, Calif., Feb. 20.

1963 International Solid State Circuits Conference, sponsored by IRE, AIEE and University of Pennsylvania, Philadelphia, Feb. 20-22.

Quality Control Conference, Western Region, ASQC, Flamingo Hotel, Las Vegas, Nev., Feb. 21-22.

The Meaning of Skybolt

THE EFFECT of the Administration's decision to cancel the *Skybolt* missile program will be far-reaching.

Its political overtones, both domestic and international, will change the future of programs other than the air-launched ballistic missile.

Perhaps the most obvious is the military shift in the years ahead to almost complete dependence on intercontinental missiles for the strategic role—to the exclusion of aircraft.

With the RS-70 cutback to a research program and with cancellation of *Skybolt*, the nation's deterrent power will rest solely with *Atlas, Titan, Minuteman* and *Polaris*.

This will mean a step-up in the *Minuteman* buy in the new budget and new emphasis on *Polaris*.

But lying behind the cancellation is some new thinking which can shift the course the industry has followed. Its significance: a decision has been made that there is a maximum deterrent.

Once U.S. ICBM strength reaches this maximum, there will be no need for an "over-kill" capability since the force in being will be able to accomplish the total destruction of the enemy.

There is, of course, a need to make certain that new defensive weapons do not obsolete this deterrent force. It also is necessary that the deterrent force be large enough and sufficiently well protected so that it can absorb the enemy's first strike and still accomplish his total destruction.

But Secretary McNamara has decided that the *Skybolt* ALBM is not among the weapons required to bring the deterrent to this strength.

In that sense, his decision was financial as well as military. There is a limit to the money which can be spent by this nation on defense. Upkeep of the aging B-52 aircraft, further development cost of *Skybolt*, and operational cost of the bomber-*Skybolt* combination on patrol would add up to a staggering sum.

It would be unwise to spend this money if *Skybolt* does not add significantly to the maximum deterrent.

The axe has been a long time falling on *Skybolt*. This magazine reported over a year and a half ago that uncertainty about *Skybolt* was endangering the Anglo-American Alliance. We reported early last year that concern over the tremendous cost overruns of the program might lead to its cancellation.

Despite the successive technical failures which preceded the final *Skybolt* launch, the ALBM cancellation was not for technical reasons.

Certainly, *Skybolt* was having technical difficulties. The constant position plotting required for the bomber-missile combination makes the *Polaris* requirement seem like child's play. But it is within the state of the art. Northrop Corp. has been a leader in missile guidance since *Snark* and we are confident any problems in that area would have been solved.

It is equally certain Douglas Aircraft could have worked the bugs out of the missile itself. One has only to remember *Atlas* and *Titan* to realize the foolishness of condemning a program on the basis of early technical troubles.

Skybolt's demise can be attributed almost entirely to financial reasons. A highly successful test program might have made the decision more difficult, but it is unlikely that, in the end, it would have changed it.

For one thing, the program was oversold on the basis of what it would cost. It is a good example of what Secretary McNamara is talking about when he accuses the services of underestimating program costs in order to obtain program approval.

In the light of this cost increase, the program no longer made good strategic sense.

THE DECISION is one that will not be taken lightly by the bomber set of the U.S. Air Force. It means an end is in sight for the manned bomber as part of the strategic deterrent.

When compared to the wild blue yonder, sitting underground in a hole in Montana day after day has little appeal.

One result to be expected from the decision is that the Air Force will press harder than ever for a military space role. This makes more sense and, in the long run, will benefit the Air Force itself far more than maintenance of the bomber force.

Another program which will be affected by the cancellation is *Hound Dog*. If a thousand-mile missile does not make good strategic sense, a five-hundred-mile ALBM makes even less. *Hound Dog* is much further along than *Skybolt*, of course, and there is even a proposal for an advanced *Hound Dog* which could fill much of the *Skybolt's* function But the basic decision—by the very fact that it was not technical—writes off any extended future for *Hound Dog* as well as *Skybolt*.

Prime Minister Macmillan's acceptance of *Polaris* as a substitute for *Skybolt* also can be expected to affect the future of the mobile mid-range ballistic missile.

The Navy long has pushed a barge-mounted or truck-mounted *Polaris* as an alternative to *MMRBM*. Acceptance of *Polaris* as a weapon which would become part of a NATO force will certainly make *MMRBM* production much less likely.

Thus, while the ALBM decision has brightened the future for those companies in the *Polaris* and *Minuteman* programs, it has been a blow to those involved in *MMRBM, Hound Dog* and *Skybolt* itself.

The McNamara decision on *Skybolt*, coupled with the RS-70 cutback, will not be popular among the manned bomber advocates in Congress.

But the industry should be prepared to accept it. It makes good sense.

William J. Coughlin

Systems Analysts & Preliminary Design Engineers for Advanced Space Guidance & Control Systems

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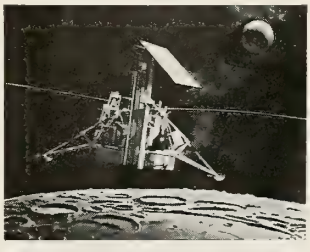
To plan digital simulation for studies related to earth orbital, trans-lunar, interplanetary and reentry trajectories; analog simulation of rendezvous guidance and control systems.

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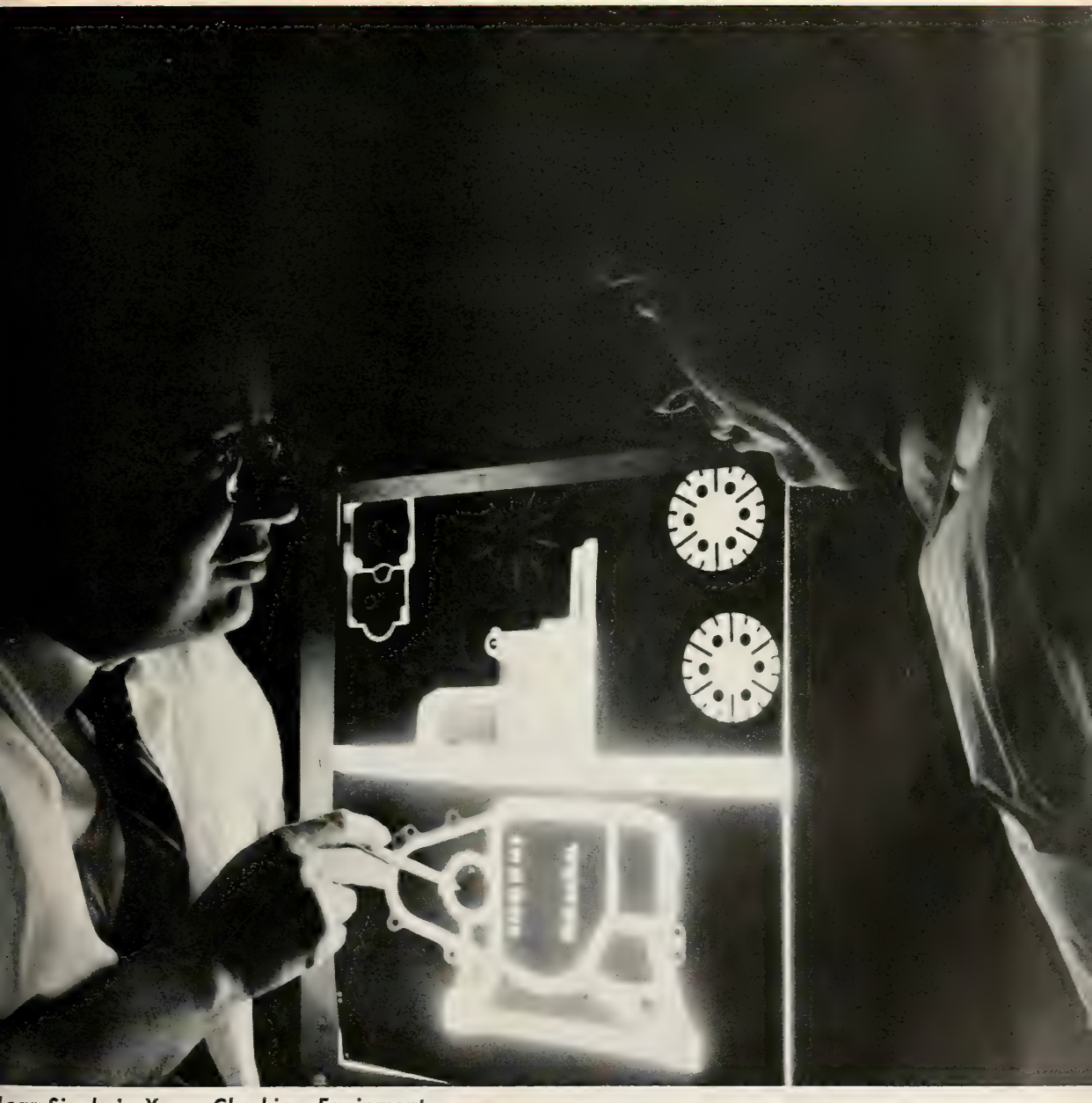
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E WEEKLY OF SPACE SYSTEMS ENGINEERING



Lear Siegler's X-ray Checking Equipment

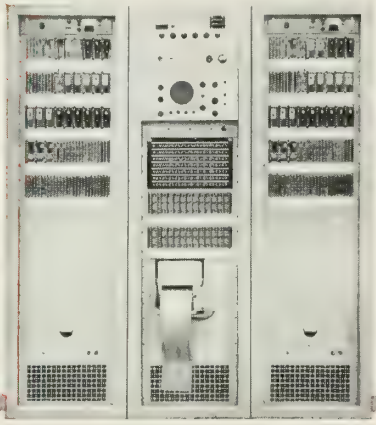
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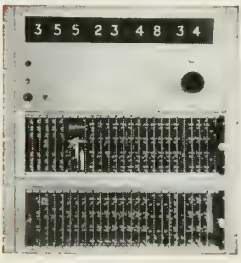
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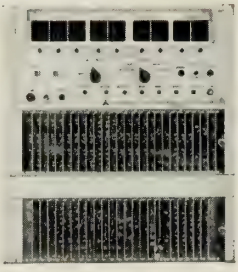
Model 6220 UNIVERSAL... translates all serial time codes to decimal display... parallel BCD output. Tape Search and Control Units (Models 6224, 6225, 6226) available for universal automatic tape search.

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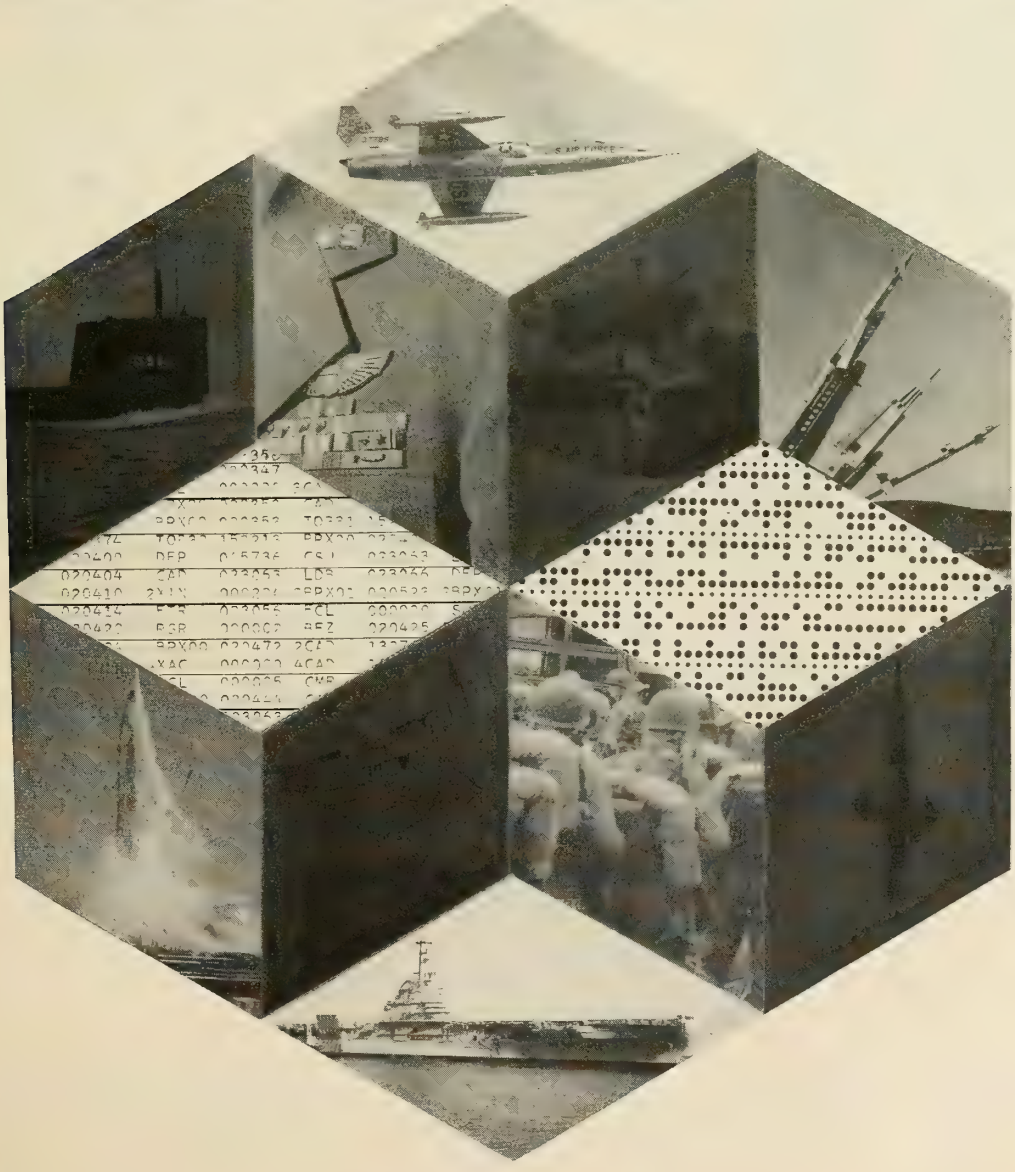
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 2 January 14, 1963

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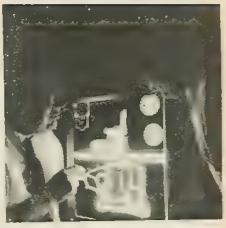
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THE COVER



X-ray photographic equipment capable of penetrating an inch of steel is used by engineers in Lear Siegler, Inc.'s Materials Laboratory to detect hidden flaws in castings and to examine internal construction of electronic components without damaging them.

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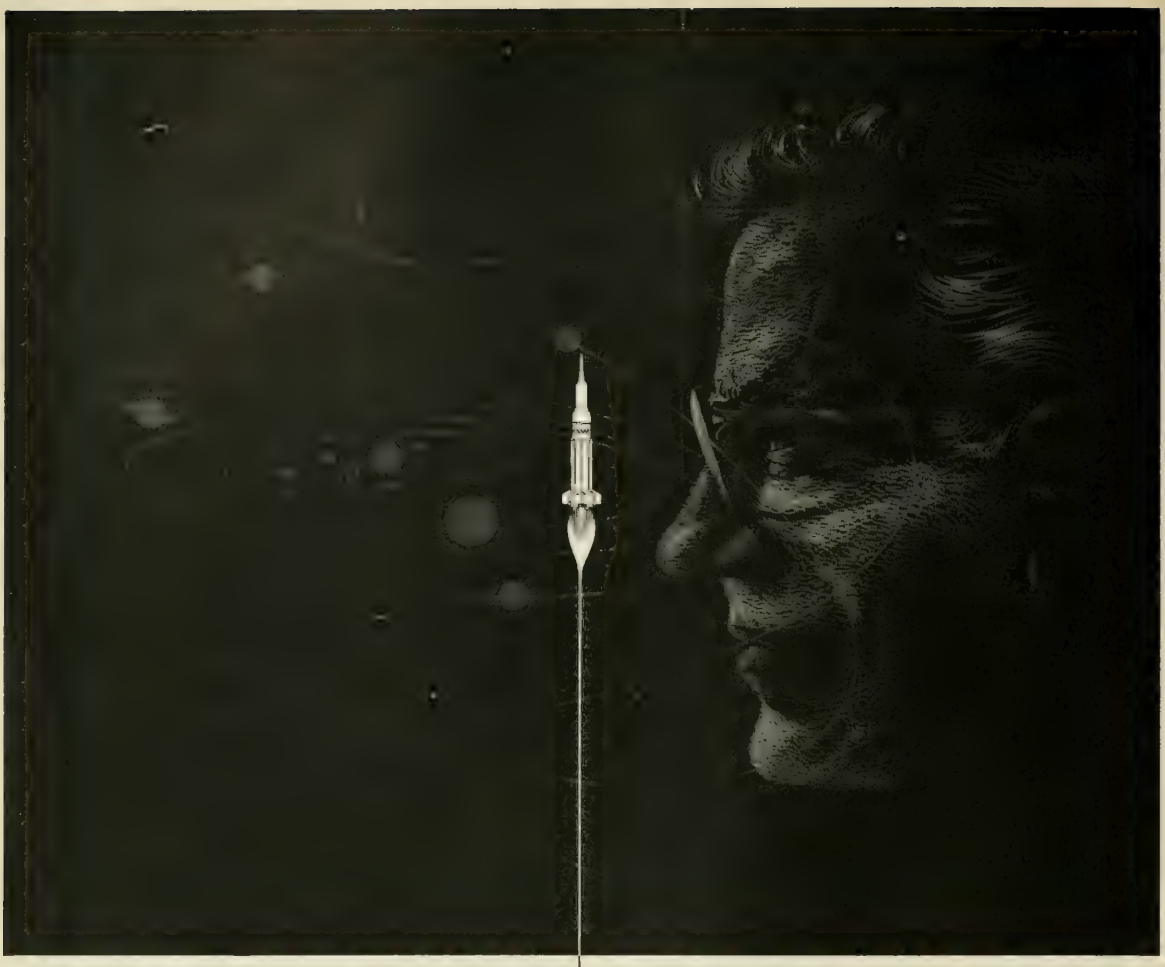
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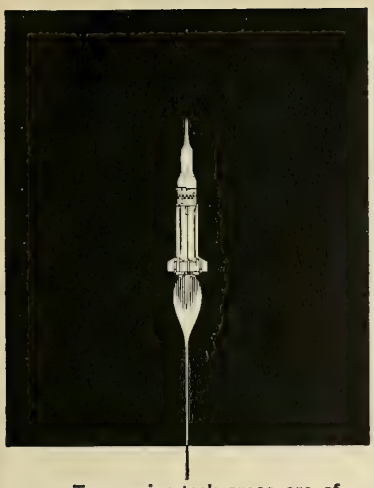
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letters

Amplification

To the Editor:

I feel that I must comment on Mr. Frank M. Cameron's letter (M/R, Dec. 24, p. 7) concerning a letter I co-authored (with B. Spencer Isbell).

While Mr. Cameron does not choose to see the reason for our letter, I trust that most readers realized that our expression of concern was related not so much to the merger *per se* as to our feelings about the conduct of the merger. Indeed, our feelings may be groundless, but we were both confused by first learning of the voting from a non-ARS source; not, mind you, the outcome of the vote, but that a vote had been cast at all. Further communication with ARS is helping to clarify this.

Further, Mr. Cameron seems to feel that our negative reaction to the ARS/IAS merger implies that we do not want the establishment of a broader availability of papers on astronautics to members of both societies, or that only with such a merger could such availability be realized.

There are several alternatives that could have been employed which would allow greater dissemination of papers throughout the technical societies without necessitating a merger. As an example, several physical societies in Europe publish a joint magazine; such a pool magazine could have the effect of giving papers inter-society distribution without a merger.

I had been an ARS student or associate for a full decade, and have seen it grow from a relatively humble status to a dynamic organization. I felt this particular merger a mistake, but I was not anti-merger as such.

I trust this commentary will clarify our positions regarding merger, this particular merger, and our previous communication to M/R.

Stephen A. Kallis, Jr.
Ex-member, ARS
Huntsville, Ala.

History Repeating

To the Editor:

Although the *Aeroplane* no longer deals with missiles and rockets, I keep myself up to date with your weekly. Reading your Dec. 17 editorial ("The Toughest Customer in the World"), I was fascinated to find, once again, that your great country runs into the problems we had to solve some years ago.

I was particularly interested in the paragraph headed "Open Bidding." This was a long-time grievance of the British aircraft industry. One has to sympathize with the Government that has got floor space going vacant, as happened to our industry before the War (and as is the case again today). Presumably the fair answer here is to let the production order go to the lowest bidder (which should succeed in making production methods competitive), and to ensure that the price paid to the successful bidder includes agreed royalty to the firm that designed and developed the product.

We also ran into this trouble for about the three years normal for military assignments. As far as I recall, we only got over this in certain specific instances.

Thurstan James
Editor
The Aeroplane and Commercial Aviation News
London, England

Radome by BIRDAIR

To the Editor:

We were surprised, and pleased, to see *our* air-supported radome on the cover of your Dec. 17 issue. My congratulations to the Bendix P.R. Department for their enterprise in obtaining such excellent photo coverage and acknowledgment (The Cover story). I also note the story on General Electric's antenna contribution (Item 3, p. 21).

Since 98% of the cover photo is dominated by the air-supported radome, designed and manufactured by BIRDAIR Structures, Inc., do you think we could get a mention?

Alvin C. Smith, Mgr.
Development and Sales
BIRDAIR Structures, Inc.
Buffalo, N.Y.

We are happy to acknowledge that BIRDAIR, a leading manufacturer of lightweight structures, built the radome in question. The company also makes radomes for antennas in the Telstar system, among others.—Ed.

Verne's Launch Date

To the Editor:

In an advertisement on the inside of the back cover of M/R's Nov. 12, 1962, issue is a picture of an incident described in Jules Verne's novel, "De la Terre à La Lune" ("From the Earth to the Moon"). The caption reads "Finish the moon shot Jules Verne began 72 years ago," but I would like to point out that "De la Terre à La Lune" was published by Hetzel (Paris) in 1865.

W. R. Maxwell
President
The British Interplanetary Society
London, England

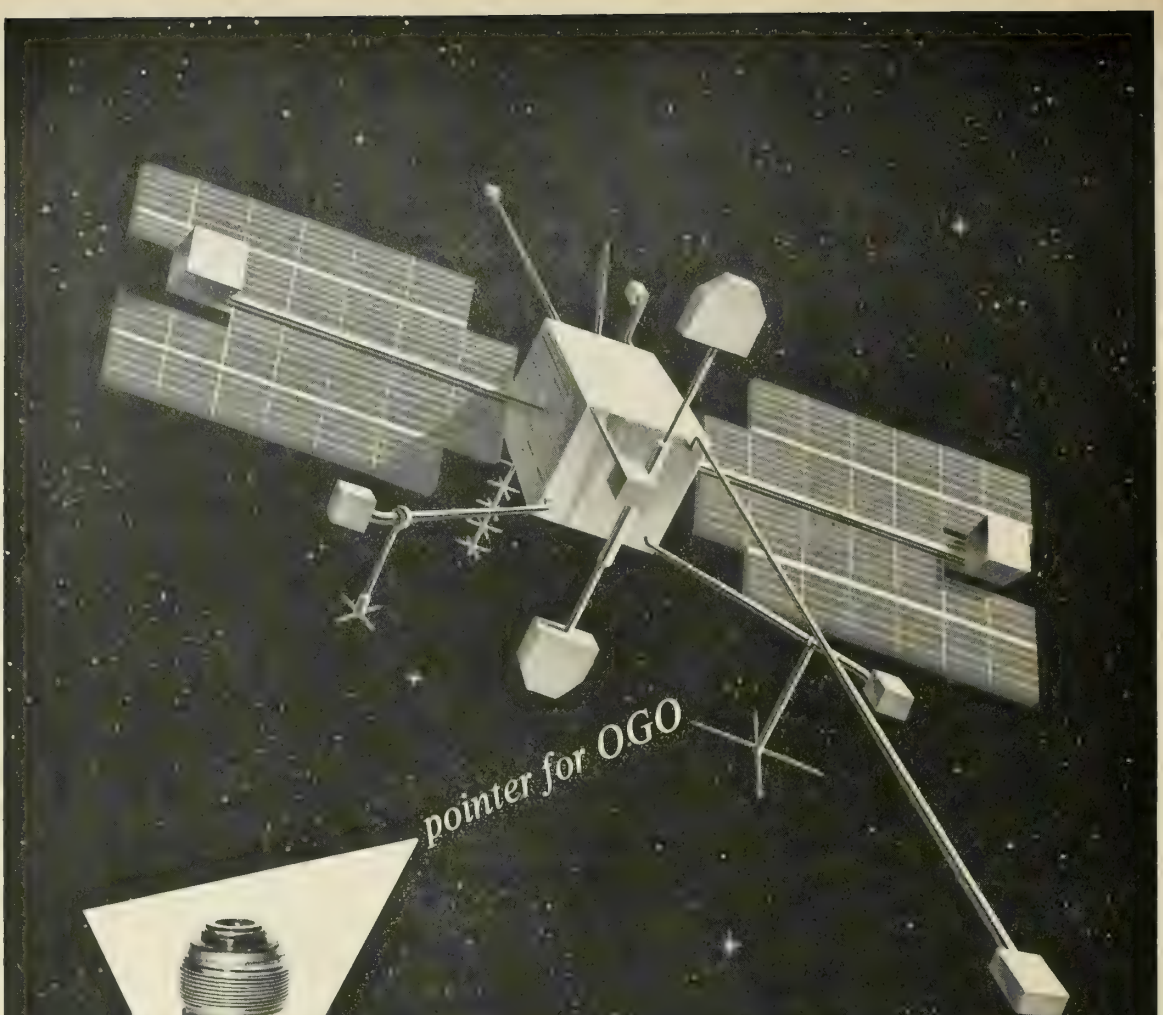
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Quantity discount prices are also available, and may be obtained upon request from the Research Department.



Once in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three directions. Some of its experimental packages must line up perpendicular to the sun's rays. Other experiments must turn to face the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar arrays in continuous orientation with the sun; a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional high-speed servo-motor without the usual problems of gear lubrication. It does its work by wabble or twist motion at a rate of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include building OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ARPA, and continuing Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Dept. B-1-3 Redondo Beach, California or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Decision Due on GEM Project

Pentagon decision on *GEM* (Guidance Evaluation Missile) is expected within the next 30 days. The test missile would consist of a *Scout* first stage topped by the second stage of *Pershing*. With addition of the third stage from *Thor-Delta, GEM* would be capable of orbiting SAC satellites. Atomic Energy Commission also is interested in *GEM* for safety testing.

Polaris to Test Startracker

Flight-test vehicle for the stellar inertial guidance system under development by General Precision, Inc., will be the *Polaris A-1*. Designated for the Mobile Mid-Range Ballistic Missile, the startracking guidance system also is intended for other vehicles.

Saturn Terminology Is Clarified

NASA finally has simplified launch vehicle terminology for the confusing *Saturn* series. *Saturn C-1* now will be known as *Saturn*, the *Saturn C-1B* has been designated *Saturn B* and the *Saturn C-5* officially will be *Advanced Saturn*.

Lockheed Is Favored for BIOS

Insiders say Lockheed Aircraft is the leading contender for the spacecraft contract in NASA's proposed *BIOS* program. The satellite will be used to orbit many forms of life, including squirrel monkeys, for long periods of time.

Pershing Overflights Okayed at White Sands

Approval has been received for domestic overflights of the Martin *Pershing* in the test program at White Sands, N.M. Firings will be made into the White Sands range from Blanding, Utah, and Ft. Wingate, N.M. These are expected to be the first such overflights although similar approval has been received for the ballistic missile re-entry research program being conducted at the range by Atlantic Research. This Air Force program employs a modified *Trailblazer*.

No Mission Set for NASA Space Station

No scientific program has been proposed which would justify launching of an orbital space station by NASA. That's the word from William A. Lee of NASA's Office of Systems Analysis. He says the station won't be considered until such a program is presented.

NASA Classification Under Investigation

Staff members of the House Government Operations Committee are pressing hard for an investigation of why NASA classified a special intra-agency report on the *Ranger* program. But the chairman of the subcommittee on government information policies, Rep. John E. Moss (D-Calif.), apparently is not interested. This means the chance of such an investigation is almost nil.

Malmstrom to Moscow: 35 Minutes

Average time to target for the *Minuteman* ICBMs at Malmstrom AFB is 35 min. The missiles have a 700-mi. apogee. Target selection, from basic target data stored on a disc-type memory unit, can be completed in a very few seconds. Complete change of the disc, which must be done manually if available target selection does not coincide with overall military plans, requires several hours

Operation Successful; Patient Died

Air Force seems determined to have the last word in that argument over the final controversial *Skybolt* launch. A press release dated Jan. 10 describes the shot as "completely successful."

INDUSTRY

Douglas to Convert Thor Missiles

Douglas Aircraft has received an Air Force contract to convert 15 *Thor* missiles to space-booster configuration. Contract, expected to exceed $3 million, calls for modification of the missiles to enable them to perform missions similar to the *Thor* boosters being turned out now at Santa Monica. Work will be done at the Douglas plant in Tulsa, Okla.

California Firms Submit Low Bid

Two California firms, Paul Hardeman, Inc. and Morrison-Knudsen Co., submitted the apparent low bid on NASA's new manned spacecraft operations building at Cape Canaveral. The $7,691,624 joint bid was the lowest of 11 proposals opened last week. The 300,000-sq.-ft. building includes a checkout facility for *Apollo* and *Gemini* spacecraft, quarters for the astronauts, offices and an auditorium.

EMR Developing Digital TV for Space

Electro-Mechanical Research, Inc., is developing an advanced digital TV unit for manned Venus and Mars flights under a research contract from NASA's Manned Spacecraft Center at Houston. Project is in the hardware stage at EMR's Sarasota, Fla., plant.

Army Certifies Sperry Calibration Lab

U.S. Army Missile Command has certified Sperry Utah Co.'s mechanical calibration laboratory at Salt Lake City as a secondary reference standards laboratory for the *Sergeant* missile system. SUCO is the first contractor to receive a certification of this nature from the Army command.

New Polaris Subs Are Launched

Two new *Polaris* submarines were set for Jan. 12 launch at the Electric Boat Division, General Dynamics, Groton, Conn., and at the Portsmouth, N.H., Naval Shipyard. Launching of the Nathan Hale and John Adams brings the *Polaris* fleet to nine deployed, one in commission but not deployed, seven launched but not commissioned, and 18 more building or authorized but not yet launched. In addition, procurement of long-lead-time items has been authorized for another six subs.

INTERNATIONAL

Terrier Is Considered for French Frigates

The U.S. *Terrier* and French *Masurca* anti-aircraft missiles are being considered as armament for the first two French missile frigates, to be built at the Lorient and Brest arsenals. The 5500-ton ships, with a speed of 34 knots, also are to be armed with *Malafon* anti-submarine missiles.

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The Missile/Space Week

Relay Vindicates Redundancy

Space agency officials are citing the revived *Relay* communications satellite as fresh support for redundant systems in space development projects.

While still not working perfectly, the satellite has been successfully conducting communications experiments since Jan. 3.

Launched last Dec. 14, the satellite failed to work because of low battery voltage. After two weeks of testing and checks, the problem was pinpointed as low voltage in transponder No. 1.

On Dec. 31, transponder No. 2 was commanded on and since that time successful transatlantic experiments have been conducted by TV, telephone, and teletype.

NASA said that difficulties in commanding the satellite, in addition to the voltage regulating problem, are still being encountered and that analysis of the problem is continuing.

The satellite transmitted a 10-minute TV show to Europe Jan. 8 during its 207th orbit.

Mariner Repeats Eliminated

The complete success of *Mariner II* has enabled space agency officials to drop plans for two repeat flights to the vicinity of Venus in 1964.

Instead, NASA said in an official announcement, its planetary exploration program will concentrate on two 1964 flights to Mars and later Venus missions with *Advanced Mariner* spacecraft.

Cooper May Go 22 Orbits

NASA's next Project *Mercury* flight may be extended from 17 orbits in 25 hours to 22 orbits in 34 hours.

A space agency official says that, though a final decision to lengthen the flight of Astronaut L. Gordon Cooper has not been made, the longer flight is under consideration.

The longer flight would be attempted to gain maximum possible experience of weightlessness with the *Mercury* spacecraft, which can carry enough oxygen, power and water for a flight of up to 22 orbits, studies indicate.

MA-9 still is scheduled for an April flight, and chances of meeting the launch date are considered good. Space agency planning continues to be based on a one-day mission, but an official said tracking, communications and recovery problems involved in a longer flight are being studied.

Shots of the Week

The pace at America's missile ranges quickened only slightly last week after the holiday season lull. These shots did occur:

- The Air Force launched another secret satellite from Vandenberg AFB, Calif., Jan. 7. An AF announcement said only that the satellite was boosted toward a polar orbit by a *Thor-Agena* combination —the same booster used in all *Discoverer* launches from Vandenberg.
- A Boeing *Bomarc B* made its first successful low-altitude aircraft intercept from Eglin AFB, Fla., Jan. 3. The strike was said to have been significantly aided by a new electronic device installed in the plane tracking the drone target.
- A Wing II type *Minuteman* was only partially successful in a Jan. 7 launch from Cape Canaveral. The silo-launched ICBM was to have gone more than 5000 miles to a target near Ascension Island. Indications were that it fell short because an upper stage quit burning too soon. The shot was the *Minuteman's* 26th; its eighth partial success. Sixteen have been completely successful.

ARC Propellant Explodes

Company officials have been unable to determine the precise cause of an Arcite solid propellant mixer explosion at Atlantic Research Corp.'s Pine Ridge plant in Gainesville, Va., which injured two persons and caused damage initially estimated at $150,000.

An ARC source said the building that housed the mixer "just disappeared" when the blast occurred on Jan. 1.

Safety officers at the facility refused to allow fire trucks to enter the area for security reasons and "because there was no sign that any fires were imminent."

The 100-gal. mixer, which had been in use for several years, was U.S. Navy property, ARC said. More modern mixing equipment elsewhere on the premises was not damaged.

Platform Set for Sled Test

The ST-124 guidance platform designed for use on *Saturns C-1, C-1B* and *C-5* soon will undergo a series of tests at Holloman AFB, N.M.

A 12-ft. sled will carry the ST-124 on acceleration and deceleration test runs of up to eight g's, and vibration test runs to about 15 g's, to determine the platform's ability to operate under such stresses.

Five test runs have been scheduled for the sled, which will carry sufficient telemetry equipment to feed back 48 channels of information.

U.K. Seeks Skybolt Salvage

Britain still hopes to salvage something from the *Skybolt* program, according to Air Commodore Sir Arthur Harvey. He has just completed talks with *Skybolt* contractors.

Harvey insisted he can't speak for the British government, but it was felt his fact-finding mission to get "the whole story" on the ALBM's scuttling has the sanction of Prime Minister Harold Macmillan and Defense Minister Peter Thorneycroft. Sir Arthur is chairman of the Conservative Party defense committee in the House of Commons.

Harvey would not disclose details of any proposed salvage arrangement, but said that President Kennedy has offered to pay 50% of remaining development costs if Britain will pay the other half and pick up the tab for all production.

Harvey said development is 75% complete, and implied that Britain might want to buy some *Skybolt* subsystems, such as guidance, for application to a British weapons system.

An increased effort on the British *Blue Steel* Mark II air-launched missile is being considered, and some *Skybolt* systems might apply. Harvey emphasized, however, that *Blue Steel's* performance is far below that of *Skybolt*.

A higher-performance substitute, and a successor to the Mark II *Blue Steel*, may be an airborne version of the recently cancelled British *Blue Water*. It would be carried by the TSR. 2 aircraft.

U.S. developments this week in the wake of *Skybolt's* cancellation included:

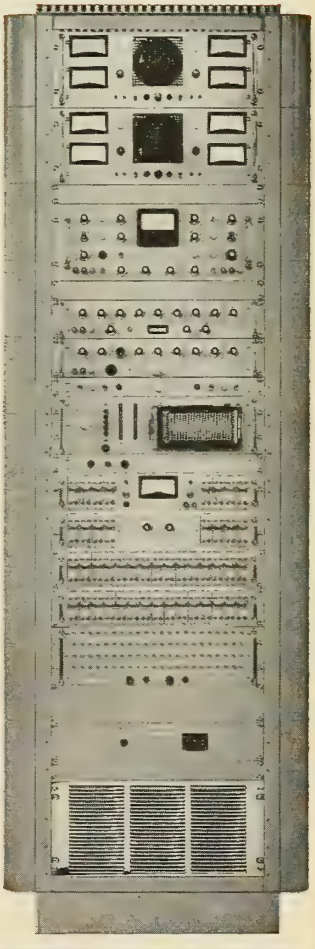
—Reports that some 4000 workers at prime contractor Douglas Aircraft Co. would be laid off within 30 days.

—Indications that Northrop Corp. and General Electric Co. will cut 2000 and 700 employees, respectively, since losing subsystems work.

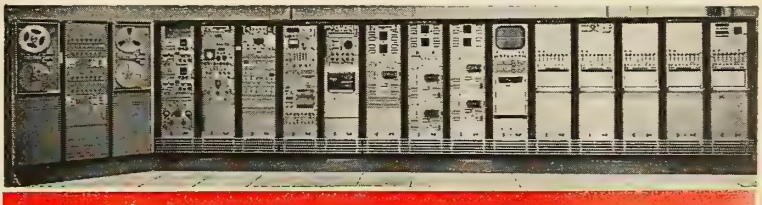
—Reports that the Air Force is considering converting *Skybolt* into an operational anti-satellite weapon or a booster for space probes.

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Beech-built "missing link" ends make-believe training

KD2B-1, now being produced under U. S. Navy contract, is another example of Beech's systems management capability

The Beech KD2B-1—shown above—is America's first missile target system to match the performance of the fastest enemy jets. **It ends the need for target towing, faking, or simulation of any sort.** By matching actual supersonic aircraft speeds, altitudes and target characteristics, it makes possible low-cost realistic training. It can evaluate proficiency of every advanced weapons system, including radar-directed and heat-seeking missiles.

But weapons evaluation is only one of the many jobs the Beech KD2B-1 is capable of doing. It has capabilities for use as an inexpensive operational missile. Its payload capacity and low-maintenance design fit it admirably for a wide range of tactical missions.

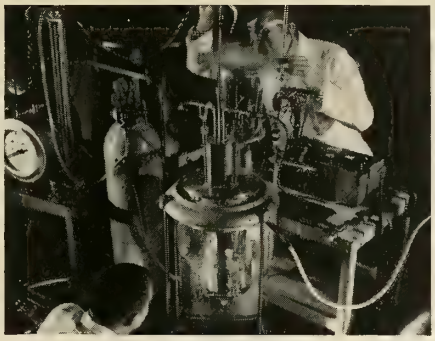
The KD2B-1 is easily adaptable to air-launching, surface-launching, or ship-launching with existing equipment. It is capable of Mach 2 speeds at 70,000 feet and Mach 3 speeds at 100,000 feet.

Designing, developing and building missile systems is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

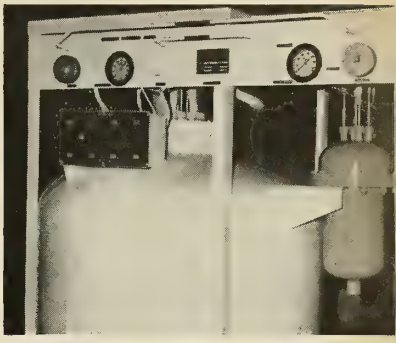
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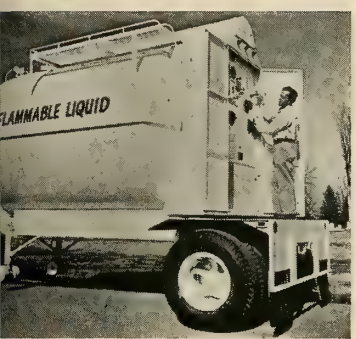
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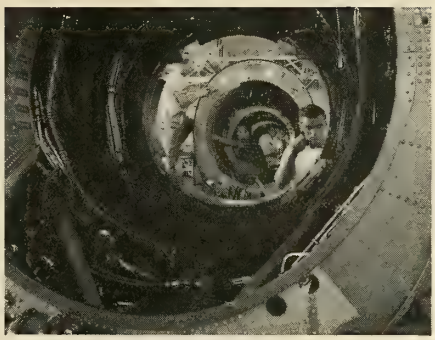
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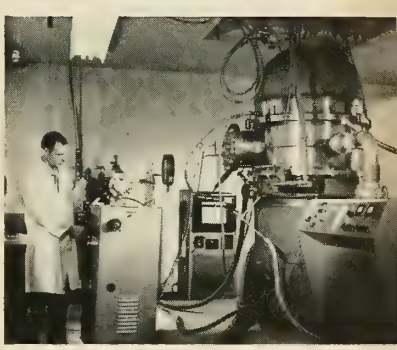
Auxiliary Power...



GSE...



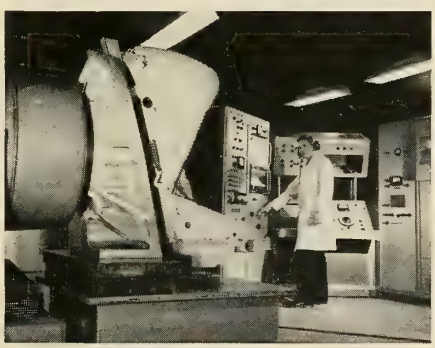
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Funding is problem . . .

LLV Design Choice Draws Near

Program approval expected to follow shortly; Pratt & Whitney works on variable-thrust engine

by Hal Taylor

FINAL DESIGN of the *Lunar Logistics Vehicle* will be decided in about six weeks, but a lack of funds may delay a start on the program.

Nevertheless, NASA officials already have taken one major step leading toward development of the vehicle, which will support a manned lunar landing.

Pratt & Whitney Aircraft Corp. has been selected to develop a variable-thrust RL-10 liquid hydrogen engine. While no definite mission has been assigned to the engine, officials told MISSILES AND ROCKETS its biggest potential use is to power *LLV*.

The lunar supply system still has not received program approval at space agency headquarters. Officials in NASA's Office of Manned Space Flight Center believe that approval will be obtained as soon as a final configuration is established.

They estimate that bids from industry on its development may be requested by the middle of this year.

Procurement action may be delayed, however, because no major space agency funds are earmarked specifically for the program, which will cost an estimated $500 million.

Because of high *Apollo* program costs, little Fiscal 1963 money is available for *LLV*. It has also been learned that the program is not included as a line-item funding request in NASA's Fiscal 1964 budget, which will be sent to Congress shortly.

Thus a major development program would force NASA financial experts into a vast reprograming of funds committed to other projects.

Reprograming of Fiscal '64 funds would have to await final Congressional approval of that budget—probably late this year. It is unlikely that much reprograming could be done in Fiscal '63, because a vast shifting of funds has already been required by manned spaceflight projects including the Lunar Excursion Module (LEM) of *Apollo*.

Perhaps the easiest way around the funding problem would be to submit a supplementary authorization and budget request for *LLV* to Congress. It is not known whether this is being considered by NASA officials.

• **Deliberations**—Development of the system and program approval within NASA have been delayed by the sheer number of design studies being made by industrial contractors and by the space agency itself.

Three primary systems are being weighed. One, with the *Saturn C-1B* booster, would have a payload of about 1500 lbs. A second, utilizing the advanced *Saturn (C-5)* launch vehicle, would have a payload of 25,000 to 30,000 lbs. Also being given serious consideration is the use of an unmanned LEM.

Another important aspect being considered is the time scale when such *LLV* flights will be required. Some officials believe they should precede manned lunar landings, or at the very least, be made jointly with Project *Apollo* missions. Others believe they could be delayed until needed to help supply a manned lunar base.

Despite the lack of decision on the supply system, NASA officials said the contract for the RL-10 was awarded so that the engine would be ready when needed. Reportedly, certain *LLV* configurations would require from one to three engines.

Even this development program is admittedly a low-key effort. The first contract with Pratt & Whitney is valued at $1.9 million for a period of three months. Officials said that only about $5 million is available for the project for the rest of the year.

• **Suitable subject**—Pratt & Whitney has developed the RL-10, the nation's first hydrogen engine, for NASA's *Saturn* and *Centaur* rockets. The engine has a rated thrust of 15,000 lbs. Under the new contract, the firm will build into that engine the capability of operating with as little as 12½% of its rated thrust.

The engine will also have a multiple restart capability.

NASA engineers point out that the RL-10 is in advanced development, is a "mature" engine and therefore a good subject for this pioneering work.

Last year Marshall granted a $900,000 contract to Pratt & Whitney to study the feasibility of the project. The company's demonstrations at its Florida Research and Development Center, near West Palm Beach, were successful. Throttleable RL-10 engines have been fired both at the Florida plant and at NASA's Lewis Research Center, Cleveland. In the tests, the engine was throttled down to 15% of the thrust.

An engine with variable thrust would be of great value in such missions as bringing two objects together in space, or landing a craft gently on the Moon or a planet. The present work will define the state of the art of such a variable-thrust powerplant. ¤

F-1 Engine Reported Hit by Instability

COMBUSTION instability problems are reportedly plaguing the Rocketdyne F-1 engine program and one government official predicts serious trouble for NASA's *Saturn C-5* propulsion unit if they continue.

The engine had combustion troubles about a year ago, but these were solved through a new baffle design. In addition, recent tests have included deliberately induced instability in firing runs under one sec.

A three-man task force from NASA's Marshall Space Flight Center arrived at Rocketdyne last week. MSFC spokesmen called this a normal progress conference originally scheduled for December, but at least one NASA Headquarters official hurriedly joined the group.

Marshall spokesmen say the engine is on schedule and development is proceeding as planned. The engine is slated for its preflight rating tests in mid-1963, with deliveries to NASA for *C-5* mating to follow shortly afterwards. Any delay could affect the launch vehicle schedule—and the entire *Apollo* program.

Rocketdyne refused to comment on the reports of combustion trouble, but NASA's official position is that these have occurred in other engine programs and there is no reason to believe the F-1 trouble cannot be solved.

Both decoders working . . .

Telstar Repair May Have Wide Import

Experience should aid new designs; some changes already made in Telstar II, slated for May launch

by Michael Getler

NEW YORK—The successful, unprecedented in-flight repair of *Telstar I* by Bell Telephone Laboratory scientists last week may make it possible to telescope the state of the art of ComSat design.

Now that the cause of the *Telstar I* failure and its remedy are known, the lessons learned during the weeks when the satellite was first silenced and then restored to operation could permanently influence several aspects of future ComSat design—among them orbital parameters, selection of semiconductor components, location of command modules within a spacecraft, and amount and type of shielding.

Some of these influences, primarily those which can be accomplished through changes in the satellite's exterior, already have been incorporated into *Telstar II* (M/R, Jan. 7, p. 13), which is still scheduled for a May launching from Cape Canaveral.

Failure of the first *Telstar* was caused by damage to silicon transistors in both of its on-board redundant command decoders. BTL said a combination of radiation levels 100 times more severe than anticipated precipitated surface degradation of the transistors, and the breakdown was accelerated by the continued presence of a reverse bias, or voltage, on the devices.

• **Early warning**—The real basis for the diagnosis and subsequent repair of *Telstar's* troubles began in October, 1961, when scientists from Bell and the Brookhaven National Laboratory discovered unexpected surface degradation of a gas-encapsulated transistor being used in nuclear experiment instrumentation.

A subsequent report pointed out that the harmful surface effects are caused by high-energy radiation penetrating an enclosed semiconductor device and ionizing the gases inside. Presence of the reverse bias condition tends to accelerate the detrimental effects of the ion collection, causing increased leakage current and a reduction in gain. Transistors not encapsulated with gas have been shown to be less susceptible.

BTL also reported that ionization damage is generally of short duration, and semiconductors can recover to original condition if the harmful radiation or bias conditions are reduced. This was the key to the *Telstar* repair.

Bell first reported its findings to NASA in February, 1962. *Telstar I* was already being fabricated; the design was proceeding on the basis of radiation levels in space some 100 times less severe than were actually encountered. Bell undertook an intense screening process which showed that diodes and germanium transistors were in no apparent danger but that some silicon transistors—particularly those in the decoders, which had less shielding due to their location and also received considerable bias—might be susceptible to the type of surface degradation found in the experiments.

• **Breakdown**—*Telstar I* was launched July 10. The first hint of trouble came during intermittent operation in November and seemed to substantiate the effects noted at Brookhaven. Command functions, which failed to respond during the first one or two passes, eventually came on. This indicated that processing of commands within the encoders' flip-flop and gating circuits actually removed the reverse bias for short periods, enabling the decoders to eventually recover. Soon after, continuing degradation halted all command communications.

An attempt was also made to command the satellite from the NASA tracking station at Johannesburg, South Africa, while *Telstar* was at apogee and subjected to lower radiation levels. This proved unsuccessful.

In an effort to reduce the bias, BTL scientists began to search for a means of operating the command decoders through by-passing the affected transistors, which, by circuit action or by disconnecting the ComSat's storage batteries, could effectively reduce the harmful voltage.

BTL revealed that both command decoders, each containing 37 transistors, had actually broken down at widely separated intervals, beginning in August.

• **Special signal**—A decoder similar to *Telstar's* with voltage applied, was placed in a lab radiation environment. Testing revealed a particularly sensitive transistor in the "zero-gate," a circuit that recognizes the "zeroes" in the one-and-zero binary code used to command the satellite. Since it was apparent that this transistor was affected in at least one of the two decoders, engineers sought to by-pass the affected transistor by using a special command signal.

In the normal command code, a "one" is a long pulse; a "zero" is a short pulse. In effect, what was needed was a spurious signal that would register as a zero. The solution hit upon was to send as a "zero" a long pulse with a dip, or notch, in the middle. This registered a "zero" in the lab.

For a trial, equipment was assembled for sending "notched pulse" commands, capable of sending two of 15 commands to *Telstar* during a single pass. On the first attempt, Dec. 20, telemetry indicated the command worked and a switch had been turned on.

A complete tape program of all 15 commands was planned, with eventually a command sent to disconnect storage batteries. During eclipses (with solar cells inactive) all power would then be off, removing the bias from the transistors and allowing the surface effect to dissipate and restore the regular command function.

But, BTL reports, the "trick" commands were twice misinterpreted and *Telstar* disconnected its batteries ahead of time. After the eclipses that followed, it was found that normal command performance was partially restored. The treatment was purposely repeated on Jan. 2 and 3 with complete restoration of normal command function. Both decoders are now working.

• **Outlook**—Scientists are making no long-range predictions as to *Telstar I's* renewed lifetime, since the radiation has no doubt done some internal harm to the semiconductors. They say the period from now until Feb. 4 will be crucial, since during this time the satellite will be exposed to continuous sunlight.

During this same period, however, it will enjoy a more favorable position relative to the Van Allen belt. After that, for a period of about a month, the satellite orbit will take it through partial eclipses providing natural reduction of the reverse bias. ⌗

X-20 likeness 'coincidental'. . .

First ASSET Launches Due in Summer

Six launches of unmanned vehicles will test materials in re-entry, check out design theories

by Frank G. McGuire

LAUNCH OF six vehicles in the Air Force's ASSET program is scheduled to begin this summer from Cape Canaveral, with different trajectories for each of the suborbital flights. The program, intended to gather re-entry data for various materials, has now cost the Air Force Systems Command more than $10.3 million.

ASSET (Aerothermodynamic/Elastic Structural Systems Environmental Tests) uses two types of vehicles resembling *X-20 (Dyna-Soar)*, but a spokesman terms the likeness "coincidental."

AFSC's Aeronautical Systems Division, which is monitoring the program, awarded McDonnell Aircraft Corp. a a $2.14-million supplemental contract last month for work on the project. ASSET has been described as a $13-million Air Force undertaking to check out various materials combinations during re-entry.

It also will test aerodynamic theories, vibration conditions, and design and structural approaches used in hypersonic vehicles.

In addition the unmanned vehicles will correlate flight-test information with that gained during ground tests. AFSC has already run the configuration, materials component subsystems and recovery systems through the usual ground-testing procedures.

Launched aboard *Thor* and *Thor-Delta* boosters, the ASSET vehicles will be of two types; four 1100-lb. versions that will travel more than 13,000 mph at altitudes over 43 miles; and two 1200-lb. vehicles that will travel 9000 mph at more than 35 miles altitude. All test vehicles will be 68 in. long and have a wing span of 58 in., with a strong physical resemblence to the *X-20*—stubby delta wings, a flat bottom, and a cone-cylinder fuselage.

• **Test goals**—The lighter versions will have aerothermodynamic/structural (ASV) objectives, and the two heavier models will be used for aerothermodynamic/elastic (AEV) tests. The ASV models will verify environmental conditions, and the AEV models will investigate unsteady aerodynamics such as flutter and varying loads.

The ASV re-entry tests will give AF designers data on environmental control, guidance and control, instrumentation, recovery techniques and equipment, structural cooling, and radar tracking under ion-sheath conditions.



ASSET VEHICLE in artist's concept shows stubby delta wings, flat bottom and cone-cylinder body. Craft will be launched by Thor and Thor-Delta boosters.

More than 140 measuring devices will monitor the vehicle during flights —including parameters such as temperatures, pressures and heat transfer rates —and will establish correlation between aerodynamic heating, lift, drag, and pressure-prediction methods and theories. Efforts also will be made to evaluate head shield designs, insulated and cooled structures, and hot structures.

The Air Force says it expects nose cap temperatures on the vehicles to reach about 4000°F.

Nose caps, leading edges and lower test shields will be made of refractory ceramics and metals. In addition, super alloys and titanium floors will be used in the structures. Included in the metals will be columbium, molybdenum, titanium and beryllium. The Air Force has not revealed how much of the test vehicle will be structure and how much will be payload.

• **Flight plans**—No indication has been given as to the time between launchings, but all will be from Cape Canaveral. Vehicles will be recovered by conventional means—parachute, flotation system and location aids. Converted Liberty ships and search aircraft will operate off Florida's east coast to pick them up.

Glide path of the vehicles, after rocket boost to some 200,000 feet, is expected to be between 1000 and 2000 miles. A self-destruct system using liquid explosives will be incorporated into each package to insure range safety. Presence of the ion sheath makes command destruct from the ground impossible.

The present group of six vehicles has been described by AFSC as "the first program" in ASSET, which presumably will have a follow-on series of flight tests to check out sub-systems of the AF's space vehicle designs.

Among these could be Lockheed's escape capsule designed for such applications, as well as high-performance aircraft. The 8-ft.-long capsule is expected to provide safe escape for aerospace crewmen from speeds of zero to Mach 4 and altitudes up to 100,000 ft.

The capsule is described as a development study not aimed at application with any particular space vehicle. However, to ease design problems, Lockheed has used the external configuration of an F-104 Starfighter as a basis for developmental work. Current tests of the capsule have progressed so that ejection at 900 knots is expected soon at Edwards AFB, Calif. ⁂

In ambitious survey . . .

Three-pronged Role Urged for NASA

New satellites, early Mars trip plans, extraterrestrial life investigation outlined by Space Science Board

by Heather M. David

A GROUP of leading scientists has urged NASA to embark upon a program to construct a number of new satellites, begin plans for early manned trips to Mars, and make investigation of extraterrestrial life a prime national goal.

A 16-chapter survey titled "A Review of Space Research," gathered under the auspices of the Space Science Board of the National Academy of Sciences (M/R, Jan. 7, p. 13), recommends that NASA consider these new satellites:

—A geostationary satellite (which could be scheduled at an early date without waiting for the *Centaur* booster) for particle and field study.

—A satellite (perhaps short-lifetime) launched in a circular orbit of about 300 km-altitude for investigation of low-energy electrons at low altitudes over the Central Pacific, for aurorae observations at a single altitude, and measurements of the neutral atmosphere.

—An advanced *OAO*-type satellite with a large-aperture space telescope—100 inches or more—for stellar and nebular studies through the entire spectral range from soft X-rays to infrared.

—Stabilization of the *OSO* satellites.

—An advanced *OSO*-type satellite with optics of 1/10-sec. resolution for use in 1965-66. It would require electrical read-out image tubes of several thousand lines resolution and the commitment, at least occasionally, of the entire memory to this image device.

—A step-up of unmanned flights preparing for *Apollo*, and a better definition of *Apollo's* goals.

—A second-generation meteorological rocket system capable of probing the atmosphere between 30 and 100 km or even higher, costing less than $2000 and able to carry 10 kg to over 100 km.

—Small satellites limited essentially to single experiments or related sets of experiments under the control of a single experimenter or collaborating groups. NASA should sponsor the construction of these satellites, provide launching vehicles and provide tracking network facilities to get orbital data.

In addition, the study group urged the military to afford more opportunities to the scientific community to put experiments aboard their spacecraft. It indicated that these opportunities are not being exploited as much as could be by scientists outside the services.

With a number of reliable vehicles such as *Thor*, *Atlas* and *Polaris* nearing military obsolescence, the group suggested that these could be made available for scientific use.

• **Early Mars exploration**—Preliminary planning of the Mars manned landing should begin at an early date, the scientists urged, with special attention to long-lead-time items.

Immediate steps for development of more powerful ground-based equipment for bistatic radar astronomy and supporting monostatic radar astronomy should be taken at once. The planetary surfaces and atmospheres and the interplanetary medium could be studied in preparation for manned flight.

The search for extraterrestrial life was named as the top-priority scientific goal of the nation's space program. The scientists said that even beyond the scientific interest in such a search, whoever finds it—Russia or the U.S.—would score an enormous prestige victory in the rest of the world.

This search should be pursued, they asserted, through more utilization of ground-based astronomy, spectroscopic observations from balloons and orbiting observatories—and eventually from the Moon observatory, fly-by photographs and spectroscopic observations.

However, perhaps one of the greatest areas of potential lies in laser techniques; NASA is urged to support research and development to advance this technology.

• **Apollo hit**—The conferees noted that there is considerable confusion about the *Apollo* mission and its justifications. It asked the Federal government for proper exposition of the scientific concepts of *Apollo* to allay misunderstandings.

Several of the recommendations of the study group indicated that the scientific community felt it should have a more definite role in the manned spaceflight program.

Immediate contacts should be made between astronauts and astronomers, for exchange of ideas for later activities.

It urged that a meteorologist be made a member of the crew of space observatories—beginning with *Gemini*. Scientists should participate on all space missions—as astronauts, passengers or ground-based observers, the scientists declared, and astronauts should have special training qualifying them for scientific observations.

A biologist should begin astronaut-training now, to ensure availability for the first Mars mission. And an institute of space sciences should be immediately established adjacent to the astronaut training facility, administered either by contract to a major university or by NASA.

Georgia Thiokol Site Moves Ahead

THIOKOL CHEMICAL Corp. is pouring $10.5 million into its large solid rocket plant site in Camden County, Ga.

First phase of plant construction, now under way at the 50,000-acre facility, includes a casting pit, propellant mixing buildings for a completely automated mixing system, an inert parts preparation building, bunkered structures for remote control operations, a quality control lab, a ballistic test motor preparation building, and administration offices.

The casting pit, 50 ft. in diameter and 120 ft. deep, will be equipped for casting, curing and static-testing the huge motors. Propellant mixers for the initial facility will have a combined capacity of 7.75 million lbs. of propellant per month. The Thiokol/Toledo Scale Automated Batch Mixing Process (M/R, March 5, 1962, p. 36) will be included.



MISSILE TRAINING site, designed and built by U.S. airman with help of a Martin Co. expert, is now in operation at Sembach AFB, West Germany. Site uses Matador missiles, modified to simulate Mace, which is replacing it in U.S. arsenal. Martin is prime for both air-breathing weapons.



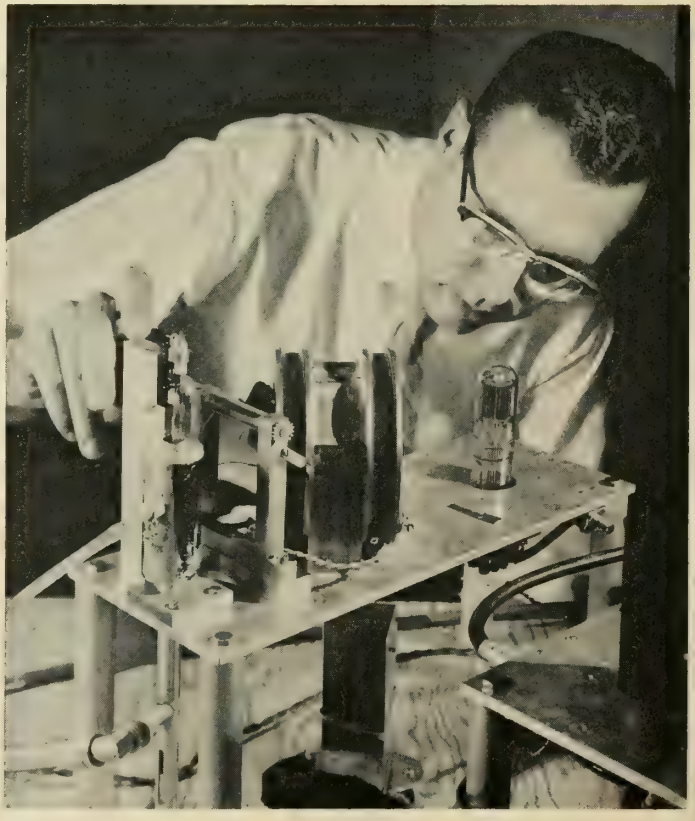
FIRST PHOTO of Searcher, rocket-launched repeater station being developed by Space-General Corp. for Pacific Missile Range. System will extend ships' search capabilities to 125,000 sq. mi.

The News in Pictures

FIRST SUCCESSFUL U.S. test firing of cluster of segmented propellant booster rockets at United Technology Center. Quadrangle of four six-segment "barrels" of solid motors produced 140,000 lbs. thrust for 14-sec. duration in Air Force-funded test.



WORKING RESEARCH model of nuclear gyro is inspected by Dr. James H. Simpson, senior scientist at GPL Division of General Precision, Inc. GPL announced last week it had operated the model, and said it was the first time such a revolutionary new type of gyro had actually been made to work. Device has no moving parts. The gyro should eventually find broad application.





ENGINEERS, EE

The 300-foot microwave test tower, and radio telescope (used for satellite tracking, communications and space research) are two distinctive landmarks of ITT Federal Laboratories in Nutley. Here, modern facilities house 17 laboratories engaged in missile and space systems, avionics, communications, research in the physical sciences, and sophisticated electronic manufacturing operations.

CLIP THIS DIRECTORY OF IMMEDIATE OPENINGS AT ITT FEDERAL LABORATORIES IN NUTLEY, NEW JERSEY

Today's opportunities are especially well timed for the engineer seeking a significant career jump now, and a progressive series of professional assignments that will provide substantial growth impetus during the months and years to come. We are most interested in talking with engineers offering backgrounds in any of the areas listed below.

PARTIAL LIST OF POSITIONS IMMEDIATELY AVAILABLE AS OF JAN. 1, 1963

COMMUNICATIONS

Mechanical Engineer, for antenna design and development. Experience in the field of satellite and missile communication antennas highly valued. Also experience in electronic equipment packaging, servo-systems and structural analysis. 5 years minimum experience.

EE; PhD desirable, with 4 years' experience in sophisticated microwave communications and tracking receivers using coherent detection and signal processing — frequency range, 1,000 mc through 10 kmc; power range, 1-through 50 kw. In addition, at least 2 years' background in communication systems design.

EE, with heavy design experience in high power amplifiers for communications; background in design of solid state control circuitry and amplifier circuitry in UHF through SHF ranges.

ME or EE, with at least 2 years' experience in electrical design and testing of coaxial, power, and communication cables and conductors to mil specs. If an ME, must be familiar with basic principles of electrical engineering such as attenuation, impedance, etc.

Project responsibility on microwave communications equipment development. Must be capable of supervising design of transistorized transmitters, receivers and modulators . . . able to handle all phases of proposal preparation.

BSEE or equivalent, with 5 to 10 years' experience in test equipment design and engineering re-design of equipment for manufacturing radio transmitters and receivers in UHF and VHF regions.

EE or Physics — MS or PhD. 3 to 7 years' experience in R&D with supervisory ability. To assist in direction of R&D projects involving Microwave systems, transistor analog and digital systems, antennas and propagation, Quantum Electronics.

Senior Scientist, theoretically oriented, experienced in communication networks, troposcatter and line-of-sight radio communication and system analysis.

EE, with 5 to 8 years' experience in design and applications of microwave antennas, transmission lines, duplexers, filters and other similar microwave components for tropo and line-of-sight systems.

AVIONICS

Managerial position, calls for 8 to 10 years' experience in the field of project management, demonstrated capability in management of the engineering and production aspects of large electronics systems contracts.

EE, with 4 to 5 years' experience in frequency control or communications field; background in frequency synthesis, HF and UHF communications.

EE, with 6 to 10 years' experience in the airborne electronic field, preferably commercial avionics; ability in the area of video circuitry for airborne communication or navigation equipments.

Senior Scientist with knowledge of and heavy experience in electromagnetic theory, antennas, receivers and RF circuitry.

DIGITAL ENGINEERING

Computer Subsystem Logical Designers — intermediate and senior level positions; to design computer subsystems, e.g., tapes, drums, arithmetic units, control. 2-6 years' experience required.

Computer Circuit Designers — for solid state design of logic elements. Good background in transistor circuitry plus strong interest in digital computer techniques. 2-6 years' experience required.

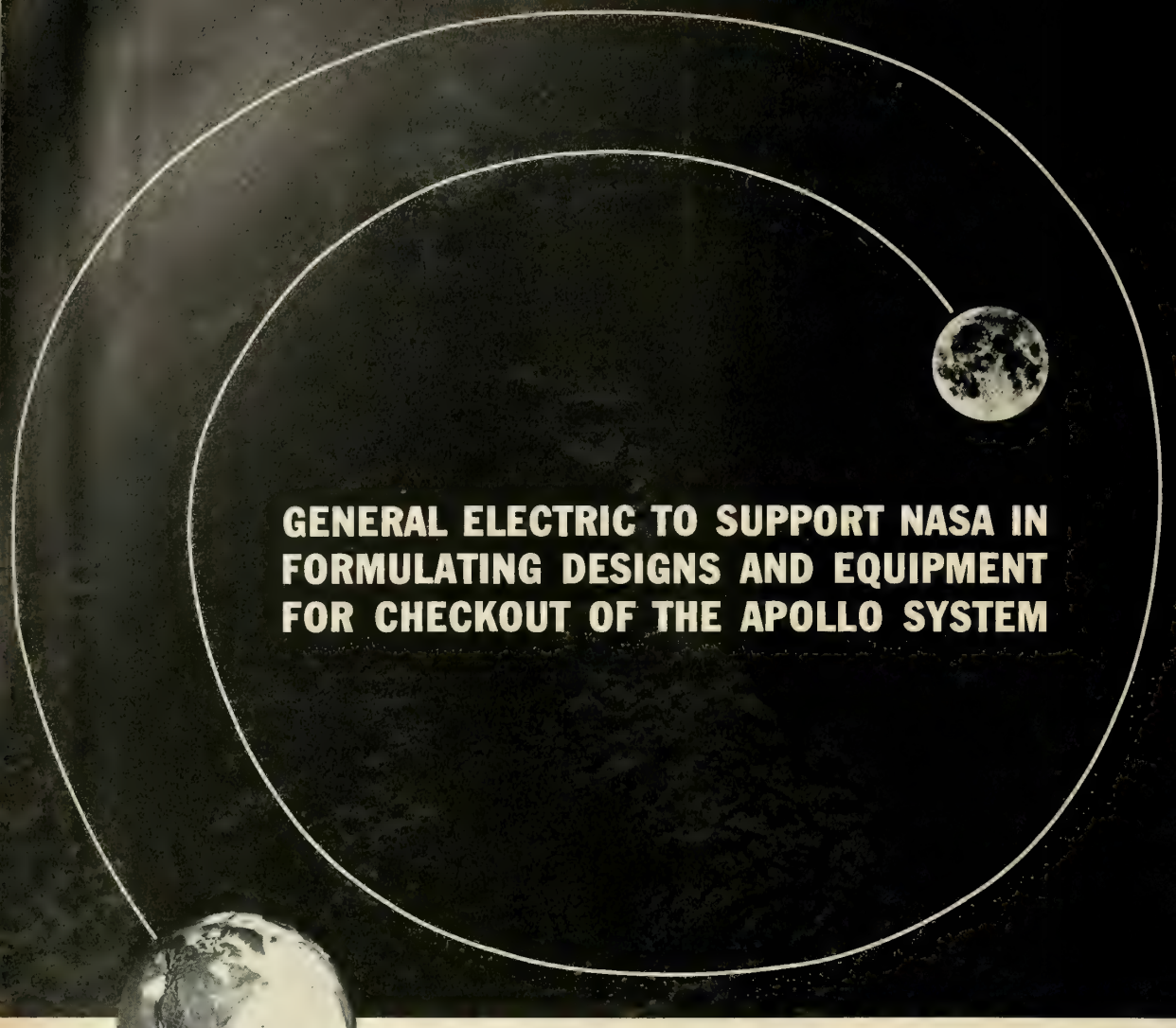
Data Processing Analysis Manager — with 4-8 years' experience, including analysis and programming on large-scale digital computer; knowledge of diagnostic, utility and executive programming; experience in planning and leading groups of programmers and analysts. BS in Math, Engineering or Physics.

Programming Analysts — intermediate and senior level, for design assistance and program production. Experience in real time operational programs, computer simulation, machine checkout programs for systems acceptance tests. 2-5 years' experience required.

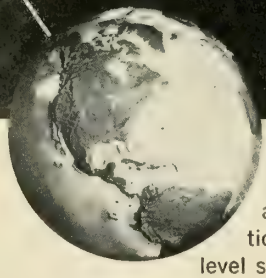
Senior Scientist with 2 to 8 years' experience in digital electronics for space applications, or mathematical analysis and probability theory, information theory.

To apply, or gain more information, forward your resume in full confidence to Mr. W. Bieszard, Box 77-WY, ITT Federal Laboratories, 500 Washington Avenue, Nutley, New Jersey. An Equal Opportunity Employer.

ITT FEDERAL LABORATORIES



GENERAL ELECTRIC TO SUPPORT NASA IN FORMULATING DESIGNS AND EQUIPMENT FOR CHECKOUT OF THE APOLLO SYSTEM



The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

Assignments at HUNTSVILLE, ALABAMA and CAPE CANAVERAL, FLORIDA

Engineering experience required in
SYSTEMS and SUB-SYSTEMS CHECKOUT and TEST PLANS, DESIGNS and OPERATIONS

Electrical ■ Electronics ■ Mechanical ■ Conversion and Guidance ■ Propulsion ■ Instrumentation and Communications ■ Telemetry ■ Pyrotechnic ■ Vehicle Systems ■ Systems Specifications and Designs ■ Digital Command Systems ■ PCM ■ Computers ■ Display ■ Analog and Digital Simulation ■ Test Simulation ■ Vibration Analysis ■ Space Mechanics ■ Operational Support Systems.

If you have experience in any of the listed areas, write us today (including salary requirements). Your inquiry will be held in strict confidence. Write to: Mr. P. W. Christos, Professional Placement, Section 73-WG Apollo Support Department, General Electric Co., Administration and Engineering Bldg., Daytona Beach, Florida.

APOLLO SUPPORT DEPARTMENT

GENERAL ELECTRIC

Technical Countdown

ASTRONAUTICS

Life in the Moon After All?

The Moon is not a dead world, *Pravda* says, but is undergoing changes. During recent years, according to the Russian report, the crater Linne has decreased to half its former size, the crater Alhazen has disappeared, and small craters have formed on the bottom of Plato. At sunrise, greenish-gray spots periodically appear at the bottom of some craters. *Pravda* adds that these spots in the bottom of crater Eratosthenes even appear to some observers to be moving.

IR Photos Point Up Lunar Relief

Russian astronomer N. F. Kuprevich reports that a series of infrared photographs shows the lunar surface has greater relief than visible-light photographs reveal. The IR photographs, however, do not record any rays emanating from Tycho crater toward the Sea of Nectar; instead, they indicate a long, high mountain range. The Russian report —published in *Trud*—claims these are the first IR photographs of the Moon. Notwithstanding, lunar photographs in both IR and ultraviolet were published as early as 1911, appearing in Astron, NacH, Vol. 188, p. 239, Germany.

ELECTRONICS

IR Acquisition Aids Radar Tracking

Missiles can now be tracked immediately from liftoff at accelerations as high as 50 g's, says RCA, using a new system that combines an infrared tracker and a radar programer. The IR/programer device, tested recently at PMR, tracks the missile through the usual ground clutter at low altitudes and directs a tracking radar so that when the vehicle is at an appropriate altitude the radar antenna is on target and can take over without hunting.

Millimeter Waves Measured More Easily

By introducing a tiny "mirror" or disc into an antenna field to reflect signal strength back to the transmitting antenna, Sylvania scientists have developed a unique technique for measuring extra-high-frequency radio energy without distorting the field. The disc, when spun, varies the reflected signal and identifies it from the transmitted signal. The reflected or received signal is then amplified and recorded. Characteristics of the field can be measured by moving the spinning disc through the field. Resultant data obtained by the Sylvania technique directly reveal antenna performance, developers say.

ASTIA To Answer Phone Requests

Technical questions on specific subjects telephoned to the Armed Services Technical Information Agency will be answered within one hour, if concerned with unclassified and unlimited release information pertinent to DOD problems. The first subject in the service covers semiconductor devices. To be added in the next few months are radiobiology, lasers and masers; ultraviolet, visible and infrared radiation; metals and metallurgy; oceanology; plasma physics; biological warfare; rocket motors and bionics. The service is available to any organization that has been authorized ASTIA services. (Specialists assigned to semiconductors can be contacted by telephoning Arlington Hall Station, Virginia, 525-5800, Extension #2479.)

PROPULSION

Titan III Subs Named

Curtiss-Wright and Westinghouse Astronuclear Division will fabricate 120-in. solid-rocket motor cases for United Technology Center's *Titan III* strap-on boosters. The segmented steel cases will reach a total length of 75 ft. Details are not yet available but one of the two subcontractors will serve as a backup or "insurance" in the motor-case program. First indications are that each will probably supply supply one set of two vessels in parallel efforts. The major subcontract award on the 120-in. booster will be for the nozzles and a contractor will be named by UTC within a month. Both Tapco Div. of Thompson Ramo Wooldridge and H. I. Thompson Fiber Glass Co. are in the running for this component.

BuWeps Approves Air-Launch Separation Device

An aircraft missile-launching system developed by Breeze Corporations Inc., and designed to overcome the air barrier build-up at the supersonic speeds of jet fighter craft moved a step closer to military acceptance. The Bureau of Naval Weapons approved the use of a separation cartridge in the system. The Navy's Mark 9 Model O separation cartridge has been under intensive testing for two years by the Navy and Beech Aircraft in the Breeze launcher, and the firm's officials are confident the system will be accepted by the Navy and ultimately used by all services.

MATERIALS

High-Temperature Coating Perfected

A vacuum coating process that prevents the corrosion of structural steel parts exposed to temperatures above 500°F through a thin film of aluminum is in operation at National Research Corp. The process eliminates impurities and permits anodizing the aluminum coating—which increases the surface hardness and abrasion resistance by a factor of 1000. The NRC method is an improvement over the current corrosion process, which involves cadmium deposition and is good only up to 500°F.

Glass Fibers Added To Shrinkable Sleeving

Bentley-Harris Mfg. Co. is producing a wide range of diameters in encapsulating insulation material combining the high strength of glass fibers with heat-shrinkable irradiated plastic sleeving. The sleeving is formed of a fiberglass fabric sandwiched between two layers of modified polyolefins. The construction, subjected to high-voltage electron bombardment in an irradiation process causing molecular cross-linking, is heat shrinkable in a matter of seconds to an accurately predetermined diameter.

SPACE MEDICINE

Eyes Affected By Exposure To Pure O_2

Continuous exposure to 100% oxygen has proven to have some unexpected effects, says Republic Aviation on completion of a study contract for NASA. Feared atelectasis —collapse of small lung sacs—did not occur, but main effects were in the eyes on the subject's return to normal atmosphere. After 14-day exposure to space-cabin-like atmosphere, subjects lost peripheral and night vision for 36 hours.

IMPACT Is Boon to Computer Users

New system, developed by Computer Dynamics Corp., said to estimate costs of programing computers to within 5%

by William Beller

IMPACT—a newly developed management method for controlling computer systems—may rival PERT as an important way to develop and keep track of complex programs.

IMPACT is being installed at NASA's Cape Canaveral launch operations center to manage computer systems involved in pre-launch countdown procedures, financial management, personnel, payroll, and other administrative functions. The Bureau of Naval Weapons is in the process of making IMPACT operational for its own needs.

The method reportedly makes it possible to estimate costs of programing computers to within five percent of actual costs—a rare occurrence today when underestimates seem to be the rule.

The computer programs, moreover, can be effectively monitored and controlled by all levels of management even though they may not be familiar with the details of computer programing.

The anticipated program costs in both money and time can be projected in detail—an obvious boon to computer chiefs having to prepare budgets, and to budget chiefs needing data to back up requests for appropriations.

• **Broken promises**—A means for controlling computer systems is long overdue. Top management in industry and government have through experience grown wary of some of the rosier pictures painted by computer salesmen and their converts. Management's attitude is shown by a facetious but nonetheless well-known rule-of-thumb: Halve the (salesman's) promises and double the cost!

This callous view has grown out of painful experiences in which managers embarked on ambitious programs involving computers without fully realizing their cost or even their purpose.

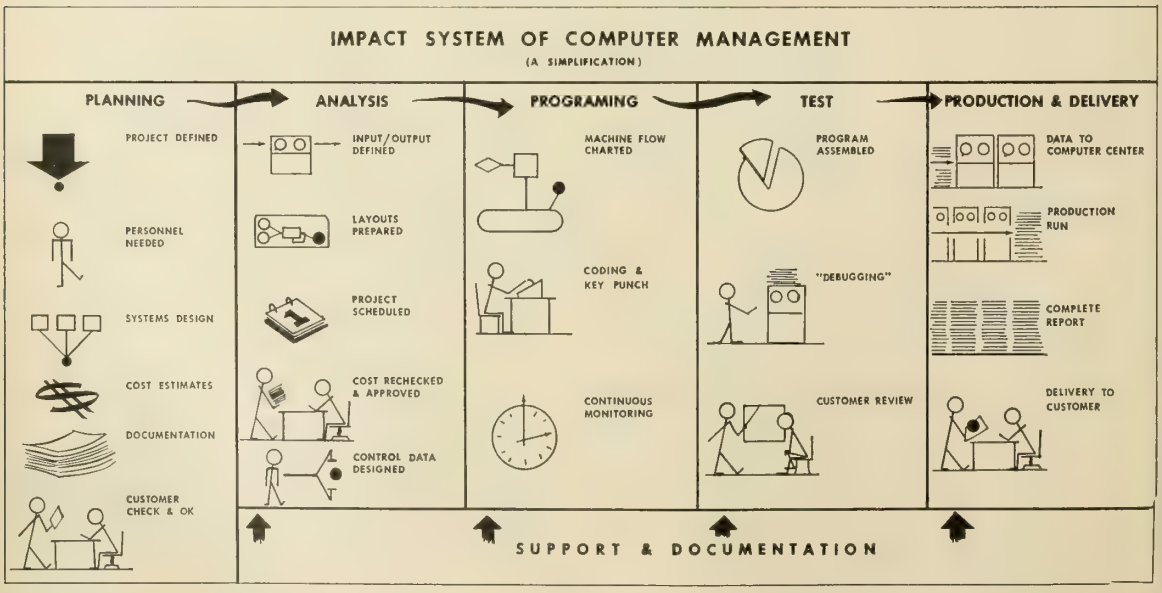
IMPACT was devised to tell management what a proposed program will cost, how much time it will take to develop, and the number and caliber of people it will take to make it operational.

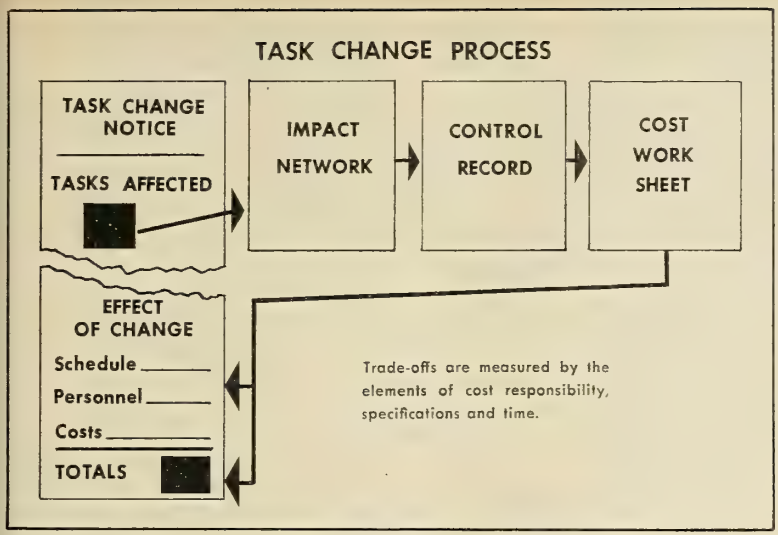
An acronym for IMplementation, Planning and Control Technique, IMPACT is in part based on PERT techniques. It was created by Computer Dynamics Corp., a company of young systems analysts and programers in Silver Spring, Md.

IMPACT is designed to get the most effective computer program for the smallest investment of time and money. With development of computer programs costing thousands of dollars and months of time, economics alone calls for a serious, organized look at computer-system-development management.

IMPACT also foretells the cost of any suggested change in a system even when the programing is under way—an important consideration once time and cost estimates have been made or when a contract officer wants to make a "small" alteration in a fixed-price contract.

The first operational use of IMPACT





occurred only six months ago in the data processing division of the Navy's Bureau of Supplies and Accounts (BuSandA). The occasion also marked the first time PERT-type principles were used for managing and controlling development of computer systems.

Using the method, Fred Winkelman, director of BuSandA's data processing division, was able to estimate accurately the time and costs of complex data-processing tasks in naval inventory-control and financial supply management. He was, moreover, able to keep continuous and firm management control over the tasks.

Programs using IMPACT have been developed for Federal Power Commission, General Services Administration, Department of Health, Education and Welfare, and Department of Agriculture.

• **How it works** — Like PERT, IMPACT is based on a network of events. Each event denotes the accomplishment of a specific task. When all the tasks are accomplished, the program is completed.

In IMPACT, again as with PERT, the path from one event to the next is measured in time—in hours for IMPACT, usually in weeks for PERT. (The Government Printing Office has published several reports on the principles and practice of PERT. Also see M/R, July 17, 1961, p. 110.)

Unlike PERT, IMPACT uses a standard, pre-printed network for program management. Comprising 63 events, the network can be used without functional change for controlling practically any computer system development, according to B. J. Hansen, CD vice president. (Hansen was one of the original team that set up the PERT-time system for *Polaris*.)

Through the pre-printed network, "instant IMPACT" can be achieved—a prodigious time-saving compared with the usual PERT method of creating a separate network for every program. In one example cited by Hansen, BuSandA in two days was able to modify the IMPACT network to meet its needs—a job that would have taken six months had it been started from a blank sheet of paper.

Another advantage of IMPACT, said company President Vincent R. Grillo, Jr., is it transfers the experience of senior program analysts to junior programers through the logic discipline of IMPACT events.

Grillo pointed out that in bidding on programing contracts his company uses IMPACT to determine its costs and estimate completion times. "This is the reason we are able to accurately bid on fixed-price programing jobs."

• **Milestones used**—As with PERT, the IMPACT network has "milestone" events. Reported on by the "exception" principle to appropriate levels of management, these milestones tell only what must be known if timely action is to be taken.

The paperwork needed to support the IMPACT system and network is straightforward and of relatively small amount. Each task is broken down into the number of man-hours by level of skill needed to accomplish it. When the number and types of personnel available are known, the elapsed time for each task can be estimated. Similarly, since the cost for each skill is known, the cost of each task can also be found. The summation of all the costs gives the final cost for producing the program.



HANSEN—created IMPACT.

• **Changes accommodated** — One major government office using PERT has estimated that a network for a typical missile/space program changes about 20% per month. This usually means the networks have to be redrawn monthly and many of the events or tasks renamed, since about one-fifth of them change every period. This is a costly procedure.

IMPACT, on the other hand, uses a standard network that presumably contains all needed events, and can more easily accept task changes. The paths affected are first determined and then, in the light of the changes, reaccomplished.

The cost of a change can be accurately determined through this procedure; a contractor, in addition, can show a customer the cost for a sign-off or a rejection. After-the-fact renegotiation is not needed.

To get the cost and time data for a suggested change, an analyst first sees which tasks would be affected by it. Then he enters the network to find the extent and number of paths involved. In this way he quickly learns what additional tasks may be involved and can easily calculate the cost of the change.

• **Looking ahead** — The need for efficiently controlling and managing complexes of computer systems is an accelerating and far-reaching one. In a report to Congress, the Comptroller-General of the U.S. pointed out that the full development of electronic means for use in government management control systems alone has tremendous significance in terms of more efficient utilization of resources.

This circumstance is particularly relevant in Defense Department programs where the 1960 inventories of supplies and equipment in use amounted to nearly $120 billion—and procurement, modification and maintenance programs involve expenditures of billions of dollars annually.

The Comptroller-General's report added: "In our reviews of selected activities, we have found that the degree of success in working with electronic systems is directly related to the amount of preplanning and study that has been undertaken before the equipment is acquired." ⁘



Northrop had many problems building its latest communications syste

Hit and run. This is how Viet Cong guerrillas operate. And these tactics were frequently successful because of South Vietnam's lack of adequate communications.

To overcome the problem, Northrop was called upon to build a complete military communications network across this troubled country.

Ordinarily, survey work alone on such a project would take a full year. Northrop had less than a year to complete the *entire system.*

But Northrop had tackled tough assignments befo Page Communications subsidiary had built comm tions systems in Turkey, Greenland, Europe, and fo Atlantic Missile Range.

This experience enabled Northrop to comp ete s work in just six weeks. Then the real work beg n. Nor engineers slogged through dense jungles and over r



One was Viet Cong guerrillas.

untain ranges. Where roads were non-existent or impass-
e, they built new ones. Lacking heavy construction equip-
nt, they improvised with the labor of willing but
skilled Vietnamese men and women.
Electronic and mechanical equipment was flown in from
e United States and hauled to construction sites by truck
nvoys, rice boats, helicopters, and primitive shoulder
kes. Every movement was made under armed guard, for
there was always the threat and the actuality of ambushes.

From this work emerged the largest mobile tropospheric scatter communications system in the world. It is extremely flexible, with truck-mounted stations that can be transported cross-country or flown to needed sites quickly and easily. It links all the military hot spots across the country.

And despite all difficulties, it was completed ahead of schedule. **NORTHROP**



NEW AMR CABLE extends present system to Antigua via Puerto Rico.

space electronics

Cable Extension To Aid in Tracking

Two underwater links, stretching more than 700 nautical miles, will connect Grand Turk Island, Ramey and Coolidge AFB's

by Charles D. LaFond

REAL-TIME tracking and telemetry data soon will be available to the Air Force Command Center, Atlantic Missile Range, through a new submarine cable extension.

Over 700 nautical miles of deep-water cable will be laid in two links —one from Grand Turk Island AFB to Ramey AFB, Puerto Rico; the second from Ramey to Coolidge AFB, Antigua, British West Indies—to substantially increase operational control at Cape Canaveral by providing down-range tracking and telemetry inputs faster and more reliably. The present operational system extends from the Cape to Grand Turk.

The cable extension, due for completion by late August, 1963, will supplant transoceanic high-frequency radio communications and a tropospheric-scatter link between Grand Turk and East Island (just off the coast of San Juan, Puerto Rico). Hf circuits will be retained for back-up.

Insiders say the cable may be only a forerunner of a vastly longer future extension running from Antigua to Ascension Island and on to a point somewhere on the west coast of South Africa. The final extension would be to Mauritius Island in the Indian Ocean and on to Perth, Australia, to tie in with tracking facilities at Woomera.

• **Shore ends complete**—Initial contracts to extend the AMR cable communications system were awarded to United States Underseas Cable Corporation in June, 1961, by the AF Missile Test Center at Patrick AFB, Fla. USUCC is jointly owned by the Northrop Corporation, Phelps Dodge Corporation, and Felton & Guilleame Carlswerk AG. (The latter firm owns the Neptun, the world's largest-capacity cable ship, which will be used for the deep-water cable laying.)

Under two contracts totalling about $5 million (and now increased to nearly $6 million), USUCC performed preliminary route studies from August to

November, 1961, and developed a detailed route survey during the following December.

These studies provided a final definitive routing from Grand Turk Island southward through Turks Island Passage and then southeast to the northwest corner of Puerto Rico at Ramey AFB. A second leg of the cable extension will continue from Ramey along a path just north of Puerto Rico parallel to the coast line, around the northeastern extremity of the Virgin Islands, and then southeast through Anegada Passage to a cable-landing point on the northern coast of Antigua.

Temperature readings and depth-sounding runs along the planned cable route and shore approach soundings were made from the cable ship, Omega, owned by USUCC affiliate Hydrospace Services, Inc. Detailed shore-end cable approach studies were made at the three terminal stations, supported by extensive SCUBA diver investigations of the sea approaches. Position fixes were obtained with a Sperry Mk2 Mod 2A direct readout Loran receiver and a Decca Model 404M navigational radar. AN/UQN-1F 6000-fathom depth-sounding equipment provided echo-sounding accuracies to better than 5 fathoms on a 100-fathom scale, the company said.

Underwater studies were performed despite rough seas and barracudas, attracted by the chrome fittings and depth gages worn on the divers' wrists.

During the deep-water survey from the Omega, the company said, two uncharted "mountains" were discovered: one at 18° 47'N, 64° 07'W at 220 fathoms; the other at 18° 04'N, 63° 26'W at 200 fathoms.

• **System components**—Each of the two cable links will be composed of two ocean "blocks" joined midway by an equalizer. The Grand Turk-to-Ramey link includes 5% slack and a 6-n.-mi. extra allowance for laying deviations from the selected track (laying cushion) and measures 339.2 n. mi. of cable. The slack prevents excessive cable tension and provides sufficient cable to permit future repair anywhere along the entire cable length.

To avoid international disputes or possible future harassment, the planned cable route never approaches closer than 13 n. mi. to the north coast of Hispaniola, the island on which Haiti and the Dominican Republic are located.

The link will contain 19 submarine repeaters and 20 full repeater cable sections. Repeaters are located 17.5 n. mi apart. The deep-water track varies in depth from 100-2500 fathoms, according to the USUCC survey.

The 337.4-n.-mi. link from Ramey to Antigua also will include 5% slack and a 6-n.mi. laying cushion. Water depths vary along the deep-water route from a few hundred to 1800 fathoms. The cable will be landed close to Port Royal Bay and continue underground for nearly 2 n. mi. to Coolidge AFB.

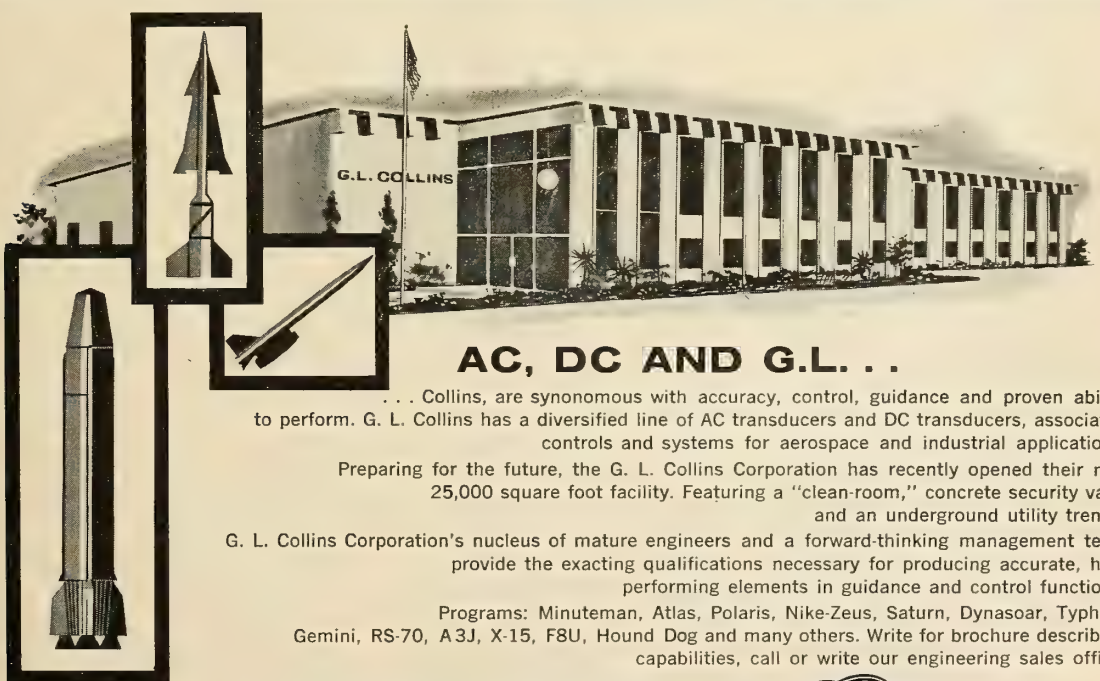
Twenty-one submarine repeaters and 22 full repeater sections are required with the same 17.5-n.-mi. separation used on the other link.

Artificial build-out will be provided from each of the three terminals.

Last October, Herbert H. Schenck, executive vice president and general manager of USUCC, announced completion of all of the shore-end cable installations.

An existing ground return system, terminating in a salt pond, is considered satisfactory at Grand Turk for carrying cable feed current. Underground cable is employed from the terminal to the shore landing. "Deadman" anchoring is provided for the cable in a coral substrata.

At Ramey, sand-entrenched cable landing will be used, with a 90° S-



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curve routing for anchorage. Two cables are used for sea-ground return. These are each 0.6 n. mi. long, terminating in special earth electrodes.

Dead-man anchorage is also used at Antigua. Six earth-return electrodes (Durichlor), measuring 2 in. dia. x 60 in. long, are implanted vertically in a salt pond.

Terminal buildings are now available at Grand Turk and Antigua. The Ramey terminal building is expected to be available this month.

All channeling equipment is government-furnished. Power-feed and carrier-frequency terminal equipment is supplied by USUCC. A previous terminal at Mayaguez, Puerto Rico, is being dismantled and will be installed at a relocated terminal at Cape Canaveral. This will prevent interruption in traffic over the existing cable system until the new terminal is operational, since the old station can be switched in at any time during the trial period.

Later, the old terminal equipment will be removed and reinstalled at the Antigua terminal.

Loading of the deep-water cable into the Neptun will begin in April. The manually wound cable is installed in two or more of the ship's five huge cable compartments at about 1 mile/hour/line. Two lines can be wound simultaneously.

Repeaters will already have been installed in the cable. Equalizers will be inserted in each ocean block during the laying operation without interruption.

Cable is laid at a ship's speed of from 6-7 knots, except for a reduction to 2 knots when the repeaters are passed through.

The final cable splice is expected to be accomplished by mid summer.

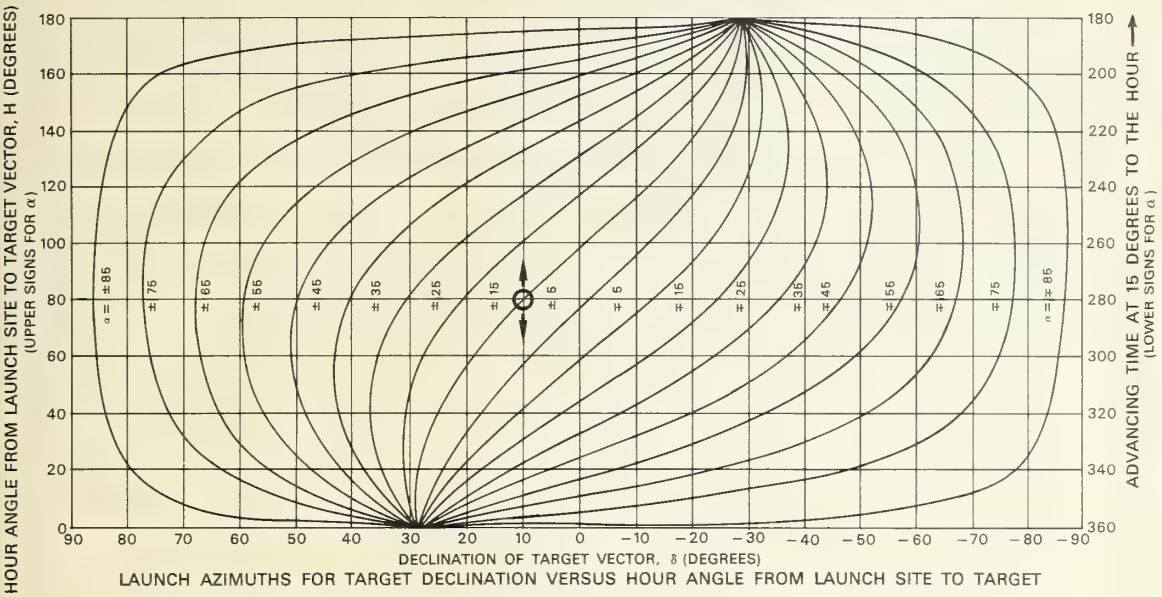
• **System limits**—The existing cable system installed in 1952 (see map) provides 12 channels from Grand Turk to the Cape. The new system can provide 60 channels from Grand Turk to Antigua.

Schenck says USUCC recently submitted an unsolicited proposal to the Air Force to raise the entire cable system to 60 channels. By employing recent technological advances in terminal equipment, Schenck observed, it would be possible to provide as many as 120 channels over the Grand Turk to Cape Canaveral link.

Pointing out the degree of reliability obtainable over cable as opposed to rf methods, Schenck said that only once has the ground potential been altered sufficiently, due to solar flares, to exceed the normal d-c voltage control. He added that present systems generally employ a constant current feed which compensates for anomalies in ground potential. ⁘

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LUNAR LAUNCH · JULY 17, 1968



LAUNCH AZIMUTHS FOR TARGET DECLINATION VERSUS HOUR ANGLE FROM LAUNCH SITE TO TARGET

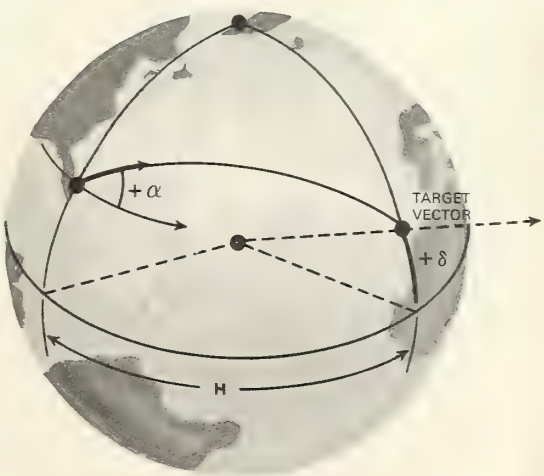
How do you launch into a geocentric planar trajectory from Cape Canaveral to a specified target vector? This family of curves demonstrates the interrelationships of the target vector declination, equatorial hour angle and launch azimuth. They can be used to estimate the launch requirements of lunar probes. For example, suppose a lunar vehicle launch is scheduled for July 17, 1968. At this time the declination of the moon will be $+10°$ (NASA Technical Note D-911). Assuming an hour angle of $80°$, the launch azimuth can be found to be $+5°$. The azimuth change for a ± 1 hr. launch window ($\pm 15°$ in H) will be $\alpha = -2°$ to $+12°$ as can be determined by moving along the $\delta = 10°$ line.

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You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics| Astronautics, 5788 Kearny Villa Rd., San Diego 12, California.

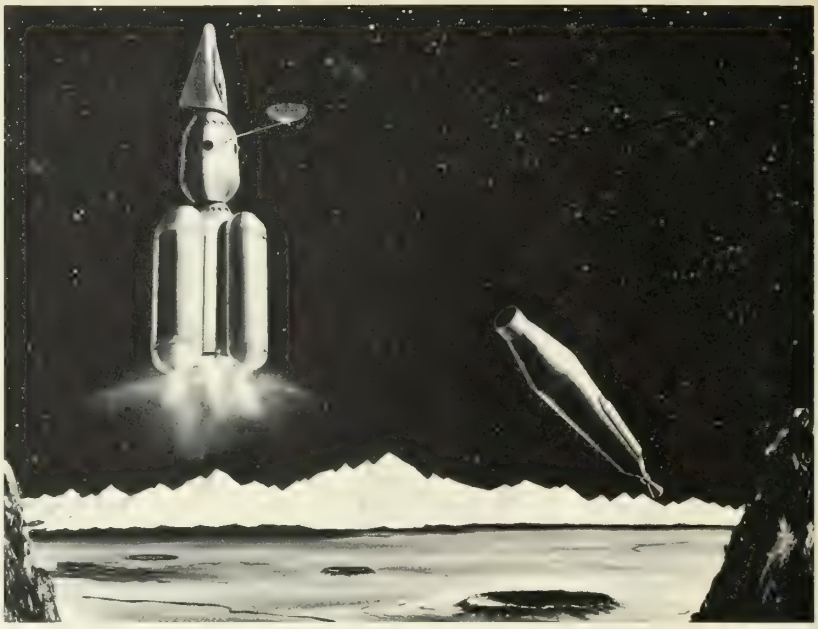


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LUNAR LANDING This spacecraft conceived by General Dynamics | Astronautics is shown backing down onto the lunar surface, controlled by powerful retro-rockets, after its journey from the earth. The discarded second-stage fuel tank is shown at right. Large tanks, clustered at base of the capsule and clamshell re-entry glider vehicle, provide fuel for landing on the moon and take-off power for return to earth. The tanks also provide a measure of protection against space radiation for the crew. Rockets are arranged at slight angles to the craft to avoid problems in landing which might be caused by "digging" holes in the surface of the moon.



DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

AEROTHERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

FLIGHT MECHANICS

Analytically talented graduate engineers at all levels required for staffing of new Flight Mechanics Development Section. Programs include aerospace vehicle guidance and automatic control, aeroelasticity, and aerophysics. Responsibilities of the Section also involve technical analyses and simulation work in support of all space vehicle programs at Astronautics.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, nuclear-propelled space vehicles, earth-to-moon logistics bus, and space stations. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is required.

GUIDANCE AND TRAJECTORY ANALYSIS

Positions exist in the following three areas for specialists who are familiar with computer techniques, possess a degree in engineering, physics, or mathematics, and have at least two years of appropriate experience:

1. Development of guidance equations and techniques necessary to perform launch, satellite rendezvous, lunar landing, re-entry, and return to prescribed earth sites. Will investigate both automatic and manual techniques, and define the proper role of man in these maneuvers. Assignments also involve the development of techniques for defining optimum trajectories for aerospace missions using the calculus of variations, dynamic programming, and the method of gradients, plus the incorporation of optimization techniques into the development of guidance equations.

2. Investigation and organization of characteristics of lunar and interplanetary trajectories. Will interrelate such parameters as velocity requirements, launch window, time of flight, inclination angles, and trajectory characteristics at the target body. Will also design trajectories to satisfy prescribed mission requirements.

3. Development of techniques for determining the best estimate of spacecraft position and velocity from optical and radar measurements within the confines of a spacecraft computer using statistical filtering.

OPERATIONS AND SYSTEMS ANALYSIS

Projects involve the study and development of advanced ballistic missiles and boosters, plus both military and non-military orbital and space systems. Responsibilities include advanced systems planning, conceptual design, and systems evaluation. Advanced degree preferred; three years of appropriate experience required.

ADVANCED SYSTEMS WEIGHTS ENGINEERING

BS in engineering with four years of experience in system and component weight allowances and controls. Will work with predesign on parametric weight analyses and design weight and balance control.

Graduate engineers will also find long-range opportunities in the following specialties: STRUCTURAL DESIGN, RELIABILITY, STRESS ANALYSIS, ELECTRONIC DESIGN AND DEVELOPMENT, MECHANICAL DESIGN, WELDING ENGINEERING.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5788 Kearny Villa Road, San Diego 12, California.

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FOREIGN TECHNOLOGY WEAPON SYSTEMS ENGINEER. Challenging analytical position to conduct technical assessment of foreign ballistic or defensive missile systems, programs, trends or advanced capability. Requires missile system experience to integrate sub-systems and technologies to derive weapon systems concepts, characteristics and performance capabilities.

PHOTO INTELLIGENCE ANALYST. A Bachelor's degree in one of the Physical Sciences is desirable, but not required. Photo training in engineering drawing—knowledge of mathematics through analytical geometry—experience in aircraft electronics or missiles. Prepares engineering drawings and reports on foreign aerospace weapon systems and components using photographic inputs.

PHOTO INTELLIGENCE ANALYTICAL ENGINEER. A Bachelor's degree in one of the Physical Sciences (engineering preferred). Training in surveying is essential. This position demands ability and interest in solving problems requiring unusual mathematical application. Mechanical aptitude and interest in precision machinery is a must. Duties involve working with an electronic computer as well as specialized photographic equipment.

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C-W Bids for Broader Space Role

Wright Aeronautical Div. combines strong R&D with traditional manufacturing methods

by John F. Judge

CURTISS-WRIGHT CORP. is combining a strong research and development effort with traditional manufacturing concepts in an energetic bid for a greater share of the military/space market.

The firm's Wright Aeronautical Div., Wood-Ridge, N.J., is moving into various space application areas with an eye toward capitalizing on Curtiss-Wright's long-recognized manufacturing capability.

Division spokesmen say that the ability to build repetitive units on a production-line economy in the highly sophisticated space field does not mean any downgrading of engineering effort. It merely involves an orientation to manufacturing techniques.

The division has been very successful in its unsolicited proposal activity, and has several other ideas "kicking around" in the pre-proposal stages.

Some of the projects in progress and under funding include incremental control systems, swirl cup injection systems, insulated thrust chambers, variable thrust systems, positive pulse systems and lithium and liquid metal cooled nozzles.

• **Novel control system**—Development of a "cap pistol" space vehicle control system announced by the firm last fall characterizes the novel approaches to space problems taken by Wright researchers.

The cap pistol is a series of tiny bits of solid propellant imbedded in plastic tape—each bit actually a self-contained solid rocket. Each has its own nozzle, propellant charge and ignition system. The tiny motors move into firing position much the same as do the rounds fed through a machine gun.

Its rate of fire, specific impulse and design details are classified, as is much of the advanced work at C-W, but the entire system can be manufactured on a production line in a manner similar to pill production in the drug industry.

The development itself impressed both the Air Force and NASA because of its reliability and simplicity of operation, which are far beyond the expectations of its developers. Early in its development, the rapid-firing unit faced problems in ignition system design. But an igniter perfected by a small chemical research firm in California—Redel, Inc. —solved this. Redel is now a Curtiss-Wright subsidiary.



'CAP PISTOL' control device typifies C-W's diversity in military/space applications.

J. DeDapper, president of Redel, invented the ignition device before the C-W merger and wound up under contract to the New Jersey firm shortly after Wright engineers evaluated the igniter.

Redel is now doing some C-W work on combustion at very low chamber pressures—on the order of 5 to 10 psi. This would permit lighter motor cases and better mass fractions. The subsidiary works on propellant formulations, not grain design. Chemical research is Redel's main effort.

• **Solid Simplicity** — The tiny solid motor avoids all the problems normally associated with liquid attitude-control systems. There is no nozzle to erode, since a new one is used in each firing. There are no fuel lines, metering problems, orifices, fuel-storage headaches, reaction-time delays or complex plumbing in the cap pistol. Firing rates can be pre-programed or done on a command basis.

Such a unit could easily handle the stringent requirements involved in satellite station keeping—one shot every half-hour for years, to take an extreme example. C-W spokesmen claim absolute reliability for the motor.

Other applications involve hot-gas generation for mechanical actuation devices such as those in swivelling nozzles or turbine starters.

Work is progressing on a larger version of the attitude-control device capable of generating thrust on the 100-lb. level. Both concepts are highly dependent on precision manufacturing. If moved into production, each miniature motor would require almost identical operational and performance characteristics. Accuracy in propellant content must be within a grain (wgt.).

Curtiss-Wright is acquiring this production repeatability by buying some new equipment. No major funding has yet boosted the program out of its "late" development status, but the Air Force intends to keep it alive because of its vast potential.

• **Graphite Involvement** — Funded work is proceeding in the area of pyrolytic graphite nozzles in which the graphite functions as a heat sink. Some development nozzles have hit 300 seconds in firing times with negligible erosion at state-of-the-art temperatures.

The program is aimed at applying pyrolytic graphite to nozzles in high-performance propellants reaching temperatures in the 7000°F range.

One nozzle has withstood temperatures around 6550°F for 44.2 seconds wtih a maximum chamber pressure of 960 psia and an average of 908 psia. The initial throat diameter was 0.602 in. and the firing produced an erosion rate of only 0.10 mils per second. Examination of the unit after the test showed less than 0.001 in. variation in the throat circumference from that of a true circle. Final throat diameter was 0.613 in.

Curtiss-Wright is currently producing nozzle components for the *Polaris.* ❖

Moon Mapping by Lasers Predicted

Hughes scientists describe radar method at Western AGU meet

PALO ALTO, CALIF.—High-power, short-pulse radar lasers should be able to map the Moon with height resolution of five feet or less within a year, two Hughes Research Laboratories scientists predict.

Charles H. Wilcox and Alexander D. Jacobson say a laser operating in the "giant pulse" or "Q spoilage" mode produces a narrow pulse of 10 nanoseconds, permitting range determination of five feet or less.

Although a system capable of producing such a beam is not developed yet, they estimated at the Western meeting of the American Geophysical Union at Stanford University that it should be feasible within a year or less at the present growth rate of laser technology.

They said the system would be useful in preparing a detailed topographic map of a selected area of the Moon—a large crater, for example. Possibly, they said, analysis of the returned beam could indicate relative flatness of the Moon within a range of 5-10 feet, although this would depend on the extent of pulse spreading.

Wilcox and Jacobson described a system which could perform the laser lunar exploration, which would require a laser peak pulse of 1 gigawatt, pulse length of 10 nanoseconds, pulse repetition rate of 1000 per second, a 40-in. transmitting telescope and a 90-ft. receiving dish.

Also at the meeting:

• K. J. K. Buettner of the University of Washington and the Rand Corp. asserted that the Moon's surface is a porous, fluffy layer of debris from meteorite collisions. He said that, after impact, some debris shoots into the Earth-Moon micrometeoric belt; but some, converted into hot rock vapor by the impact, falls back to the lunar surface. During flight and after settling back, he said, the vapor condenses and "glues" together any rock it touches.

• A team headed by Donald E. Gault of NASA's Ames Research Center reported on impact studies that indicate the velocity of debris spewed up by meteor impact varies. Some is ejected at speeds greater than the lunar escape velocity and enters the Moon-Earth belt. Some is ejected at three times impact velocity, and appears to escape the Earth-Moon system. The mass of fragments leaving the surface is more than the mass of the projectile. However, debris with velocities less than escape velocity falls back, contributing to "secondary impact events."

Results of the Ames studies "imply the presence of a lunar 'atmosphere' of flying projectiles. The major fraction of the projectiles is estimated to be concentrated in a layer a few kilometers deep." The secondary particles, with the debris, should be a "powerful eroding agent that will continually abrade the lunar surface and reduce rubble to finer sizes."



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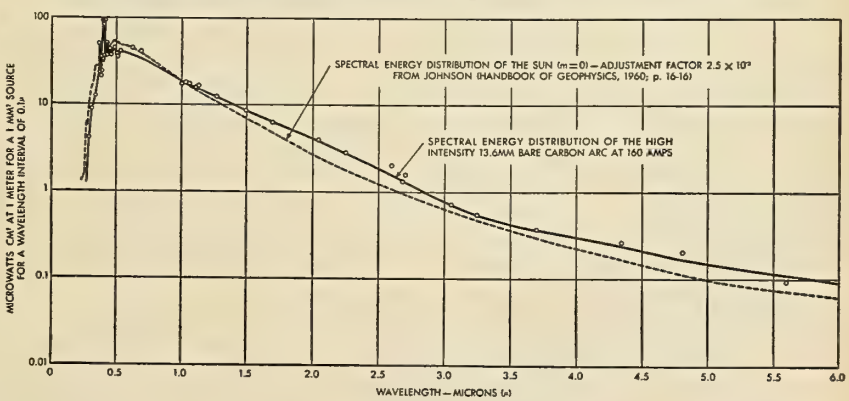
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Circle No. 12 on Subscriber Service Card

NRDS Plans Bi-weekly NERVA Tests

Aluminum test stand will be safe for personnel after three days

by Russell Hawkes

LAS VEGAS, NEV.—Officials of the Nuclear Rocket Development Station plan to test-fire *NERVA* engines at intervals of approximately two weeks, despite the problem of radioactive contamination.

The comparatively rapid schedule should be possible because Engine Test Stand No. 1 (ETS-1), designed by Aetron Div. of Aerojet-General Corp. for testing *NERVA* (Nuclear Engine for Rocket Vehicle Applications), is constructed entirely of aluminum. This material is not as highly activated by neutron bombardment as is steel; its active isotopes have a shorter half-life. This permits personnel to enter the area about three days after a test run to begin preparations for the next one. *NERVA* engines, unlike Kiwi reactors, are to be reused for a series of firings.

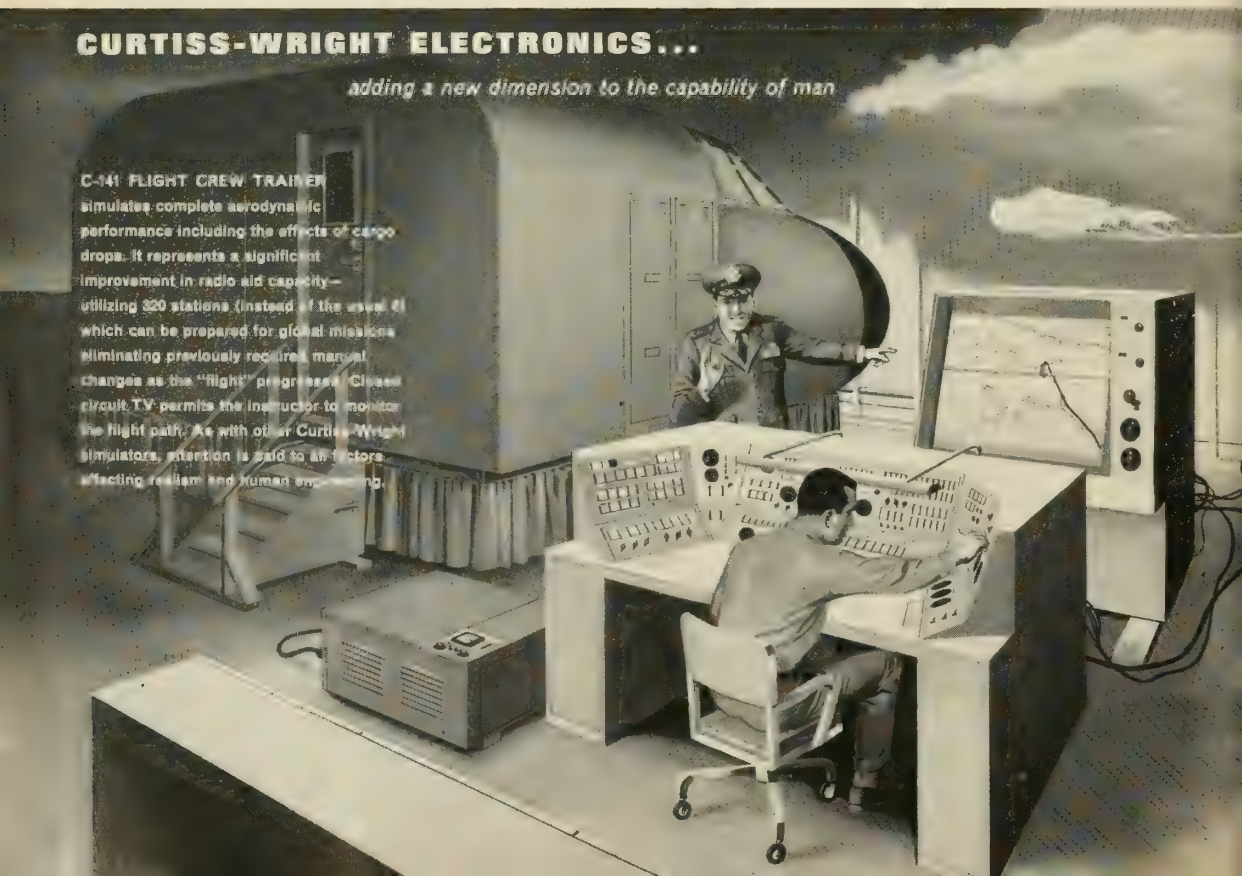
The $20-million ETS-1 will be completed by this March except for installation of the exhaust duct, reactor shielding and instrumentation. The *NERVA* engine itself, however, won't be available before late 1964 because of delays in the Kiwi flightless reactor phase of Project *Rover* (M/R, Dec. 24, 1962, p. 35).

• **Solving shielding**—Radiation shield requirements at ETS-1 are extreme because the intensity level near the reactor during a run will be about two billion roentgens per hour. The shielding needed to bring radiation in the area down to an acceptable level must be very heavy—yet movable to permit installation and removal of engines.

This problem was solved by designing the shields as hollow aluminum tanks mounted on railroad trucks. When the shields are in place they are filled with water, which is a good shielding material and can be drained into the run-off ditch along with the cooling water from the flame duct. The run-off ditch carries the water about a quarter-mile out in the desert, where it sinks rapidly into the sand, thus disposing of any radioactive materials in it. The flame duct at the base of ETS-1 can be evacuated by ejection pumping to simulate starts in space.

• **Engine functions**—Some of the non-nuclear characteristics of the *NERVA* engine have already been determined by Aerojet engineers. The propellant turbopump is to be driven by what is known as a hot bleed cycle: gaseous hydrogen is tapped directly from the reactor chamber at high pressure and at temperatures in the neighborhood of 4500°F. It is then mixed with cooler hydrogen to bring its temperature down to a less destructive level.

The gas then is ducted to the turbine

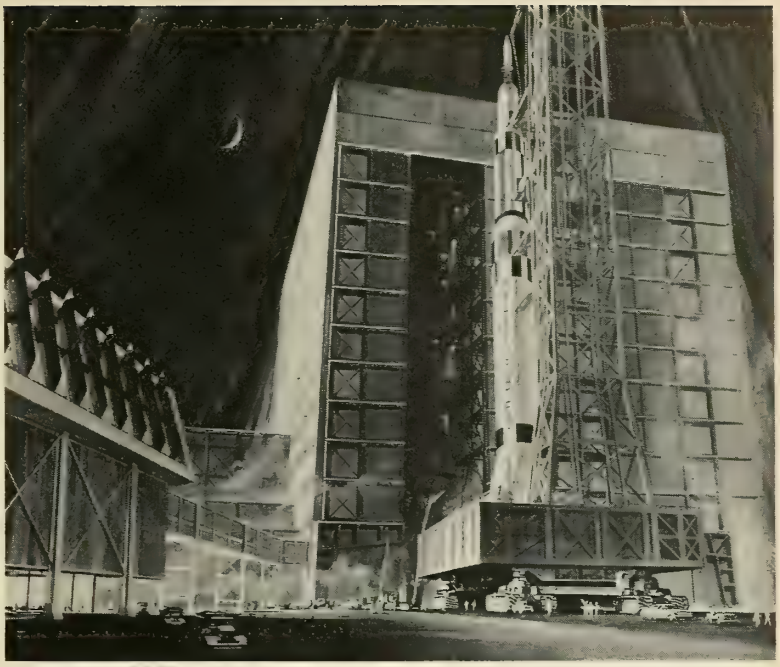


and from there is dumped overboard through a pair of vernier nozzles swiveled to control the attitude of the stage about its roll axis. The feasibility of the hot bleed cycle was demonstrated by Aerojet by actually tapping hot combustion gases from the chamber of *Titan I* second-stage engines and using them to drive turbines.

Pitch and yaw power for the nuclear stage are provided by gimbaling the engine. The position of the engine on its gimbals is controlled by pneumatic drives operating on the pressurized hydrogen boil-off from the propellant tank. The gas is fed to the actuators from four large spherical holding tanks surrounding the gimbals. In this position they afford some protection to the propellant tank against the great heat generated by the engine. The gimbals are cooled by placing them inside the large flexible duct carrying liquid hydrogen to the engine.

• **Challenges**—Aerojet engineers foresee two *NERVA* development problems. One is the development of methods of cooling and lubricating the turbopump with liquid hydrogen. Oil is not a usable lubricant because ionizing radiation causes it to gum up.

The other problem is the acquisition of knowledge about the strength of nozzle materials at cryogenic temperatures in an ionizing radiation field. ❖



Apollo Launch Structures Designed

ASSEMBLY BUILDING planned for NASA's Cape Canaveral Apollo launch facility is shown at right in artist's sketch. Moonflight vehicles will be erected, mated and checked out in the massive structure, then rolled out through 45-story doors. Checkout procedures will be directed from the four-story Launch Control Center, at left.



PROJECT IN POINT:

this C-141 crew thinks it has just completed an equipment drop

Simulation reflects the ultimate in the *application* of science and technology. It is the electronic bridge from research to reality. At Curtiss-Wright, electronic simulation systems orient men and machines to missions for many military and industrial programs.

Project in Point: Under contract to the Air Force, Curtiss-Wright today is producing a fully digital flight crew trainer that matches the high performance characteristics of the new Lockheed C-141 turbofan transport. This flight simulator is the first to use a general purpose, all-digital computer.

The C-141 is being developed as a "10-year aircraft" with built-in capability to accommodate newer power plants as they become available. This flexibility in the giant transport's design is matched by the Curtiss-Wright simulator. Because it is fully digital, the simulator can be updated easily to reflect performance changes at minimal expense and down-time.

Advanced activities like this have created immediate opportunities at Curtiss-Wright Electronics Division for solid state circuit designers, digital computer programmers and others experienced in the application of real-time digital computation to the most challenging problems in simulation.

For complete information, please write Mr. E. Gene Kelly, Manager of Professional Placement, Curtiss-Wright, Electronics Division, East Paterson, New Jersey. An equal opportunity employer.

ELECTRONICS DIVISION

CURTISS-WRIGHT CORPORATION



Out and Back. USAF's X-20 Dyna-Soar will be captured on re-entry and precisely guided to touchdown by a Sperry microwave aerospace terminal control system. □ NASA's moon-bound Apollo will receive continuous on-course data through tiny Sperry inertial devices, part of the MIT-designed guidance sub-system. □ Also for NASA, Sperry is studying which jobs man and instruments can do best in space-launch vehicles; supplying long-life spectrometers for satellites to measure the gaseous composition of space. □ A Lunar Navigation Grid System—lunar surface-sampling and return systems—laser-Doppler space rendezvous radar—interplanetary navigation-spacecraft stabilization and control—are a few longer-ranged Sperry studies. □ Sperry scientific, management and production skills are teamed for space. General Offices: Great Neck, N.Y.

SPERRY

DIVISIONS OF SPERRY RAND CORPORATION

Circle No. 1 on Subscriber Service Card

The Industry Week

Industry Facilities

An expanded engineering facility, more than double the size of present quarters, will be dedicated by Electronic Communications, Inc., at St. Petersburg, Fla., Jan. 25. The expansion adds 70,000 sq. ft. for a total area of 125,000 sq. ft. for engineering. The company also has a 125,000-sq.-ft. manufacturing area.... *Lockheed Aircraft Corp. will acquire two sites totaling 550 acres adjacent to NASA's Manned Spacecraft Center at Houston. One site of 50 acres is part of the Clear Lake City Research Park, being developed by Del E. Webb Corp. for Friendswood Development Co. as a complete community centered around modern R&D facilities. The other site, of 500 acres, is three miles away, on property of Humble Oil & Refining Co., planned for industrial park development. Lockheed says it will be the first missile/space firm to acquire property in each location. Purchase prices were not disclosed.* . . . Massachusetts Institute of Technology plans to strengthen and enlarge its research and teaching capability through a $4-million Center for Space Research. NASA will pay $3 million of the costs, MIT said, and the institute expects to raise the remainder during its Second Century Fund campaign. The center is one of several interdisciplinary facilities for advanced research and instruction planned by MIT, and one of a series of research centers NASA is helping to establish at American universities. . . . *Control Data Corp. of Minneapolis has opened a new sales office in Huntsville, Ala. Robert G. Ferris will be resident manager of the new office.* . . . Austin Co. is designing a $9.8-million heavy-steel-products fabrication plant for J. B. Beaird Co., Inc.—subsidiary of American Machine & Foundry Co. To be located on a 100-acre site near Shreveport, La., and financed by a public bond issue authorized in a special vote by Shreveport citizens, the 450,000-sq.-ft. facility is expected to be operational late this year. . . . *Five new sales-engineering offices have been opened across the nation by RADIATION at Stanford, a subsidiary of Radiation, Inc., to support manufacture of specialized electronic equipment by its R-F Systems Div. The new offices are in Boston, New York City, Washington, Los Angeles and San Francisco.*

New Representatives Named

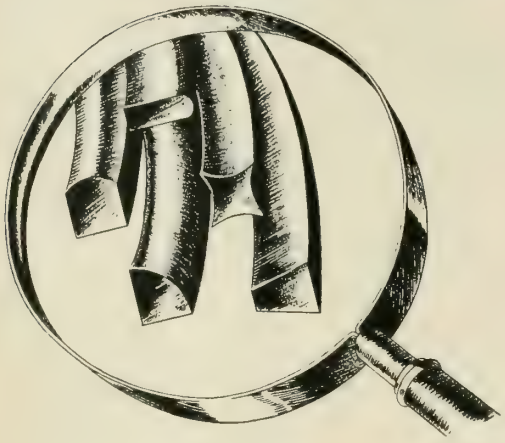
Technical Enterprises, a new Manchester, Conn., firm, has been named sole New England representative of Magnion, Inc., Cambridge, Mass., producer of electromagnets and related power supplies. . . . *Baldwin-Lima-Hamilton Corp.'s Electronics Div. has appointed another new firm, Research Data Corp. of Burbank, Calif., as sales representative for California, Nevada, Arizona and New Mexico. BLH's Electronics Div., at Waltham, Mass., produces strain gages and transducers for load, pressure, torque and temperature measurement for industrial, commercial and military applications.* . . . Pittman-Hanner, Inc., Atlanta, Ga., has been named sales representative for Adamas Carbide Corp. in Alabama, Mississippi, Louisiana, Tennessee and Virginia. Other Adamas representatives named were Robert C. Boyd for Florida and Frank H. Scheffler for the northern half of Texas. . . . *In Utah, Wyoming, Colorado and northern New Mexico, Pierce Bowthrop Agency of Salt Lake City now represents Raytheon Co.'s Commercial Apparatus & Systems Div. PBA will handle sales of the company's precision resistance welding equipment, ultrasonic impact grinders, impulse magnetizers and microwave power generators.*

International News Notes

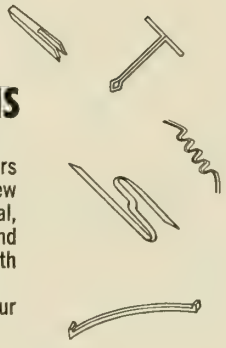
SEPR, French company specializing in rocket engine development, is acquiring land near Bordeaux, France, for a new plant expected to be operational in about two years. Several hundred technicians will be employed at the facility, which is located close to other missile/space operations. . . . *Electronic Associates, Inc., Long Branch, N.J., says its British subsidiary, EA Ltd., has received an order from the British Ministry of Aviation for a high-speed analog sampling system—said to be the first such system to be made available in the United Kingdom. The device, actually a data-scanning system, sequentially samples multi-channel input data with rapid conversion to digital information. Cost and number of units ordered were not disclosed.* . . . Compagnie des Compteurs of France has agreed to grant to Cubic Corp. of San Diego, Calif., exclusive franchise for production, marketing and servicing of a new line of state-of-the-art digital tape recorders and handlers. The franchise covers the U.S. and Canada. . . . *The Defense Products Div. of Fairchild Camera and Instrument Corp., Sysosset, N.Y., has named Stewart Aeronautical Supply Co., Surrey, England, as exclusive military products sales representative for England.* . . . A new engineering link between the U.S., Europe and Japan—designed to aid small electronics firms—has been announced by Electronic Engineers International of San Francisco. H. M. Ishikawa, Tokyo consulting engineer, has joined EEI, an association of consulting engineers living and working in America, England, and the Common Market countries. EEI offers a technical liaison network helping smaller firms establish themselves in overseas markets. The need for special guidance for these smaller firms, EEI says, is evidenced by the fact that the "giants" of the industry here and overseas have been the dominant beneficiaries of international marketing tie-ins. In Japan, for example, Sperry Rand has joined forces with Oki Electric Co.; Minneapolis-Honeywell with Nippon Electric Co.; RCA with Hitachi; Thompson-Ramo-Wooldridge with Mitsubishi Electric. Reportedly, GE now is negotiating for a similar agreement with Toshiba.

SHAPED WIRE

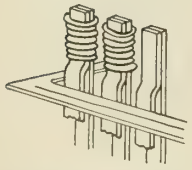
Selected for its required Electrical & Mechanical Properties

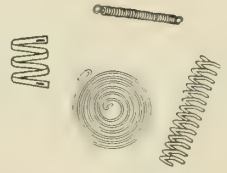


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contracts

AIR FORCE

$67,588,200—**Martin Marietta Corp.**, New York City, for work on the *Titan II* weapon system at Davis-Monthan AFB, McConnell AFB, and Little Rock AFB, and in Littleton and Denver, Colo. (4 supplemental contracts).

$43,244,300—**Martin Marietta Corp.**, Denver, for installation and checkout of *Titan II* missiles.

$34,600,000—**Federal Electric Corp.**, Paramus, N.J., for continued operation and maintenance of the Distant Early Warning System (DEW).

$6,200,000—**General Dynamics Corp.**, New York City, for research, development, test and fabrication of *Atlas* missiles.

$5,500,000—**General Dynamics Corp.**, New York City, for development, verification and delivery of technical manuals and related equipment for *Atlas* missiles. Work to be done at San Diego.

$5,037,885—**General Dynamics Corp.**, New York City, for work on design, development, fabrication, installation, checkout and activation of Point Arguello Launch Complex No. 2.

$5,000,000—**Hercules Powder Co.**, Wilmington, Del., for Stage III *Minuteman* motors (supplemental contract). Work to be done at Bacchus, Utah.

$4,620,000—**International Telephone and Telegraph Corp.**, New York City, for work on a classified communications project at Federal Electric Corp., an ITT service company (supplemental contract). Work to be done at Paramus, N.J.

$4,437,660—**Aerospace Corp.**, Los Angeles, for systems engineering and technical direction of ballistic missile and space programs as well as management services and administration support (supplemental concontract).

$3,165,000—**Ford Motor Co.**, Detroit, for work on operational sub-systems and services for *Atlas* and *Titan* missiles at Newport Beach, Calif.

$3,136,977—**Martin Marietta Corp.**, New York City, for follow-on production of *Titan I* missiles. Work to be done at Denver.

$3,119,596—**International Telephone and Telegraph Corp.**, New York City, for follow-on procurement of beacon transponder sets and related items. Work to be done at Clifton, N.J.

$3,000,000—**General Dynamics Corp.**, New York City, for *Atlas* missiles and related materials (supplemental contract).

$2,913,708—**General Dynamics Corp.**, New York City, for operation of an operational system test facility.

$2,188,000—**International Business Machines Corp.**, New York City, for system design and integration engineering for an operations control center. Work to be done at Rockville, Md.

$2,135,000—**North American Aviation, Inc.**, El Segundo, Calif., for work on the *Atlas* missile propulsion system (supplemental contract). Work to be done at Canoga Park, Calif., and Neosho, Mo.

$2,000,000—**General Dynamics Corp.**, New York City, for services and supplies for facility and launch service support at Vandenberg AFB (supplemental contract). Work to be done at San Diego.

$1,735,525—**Hughes Aircraft Co.**, Culver City, Calif., for modification kits, tools, parts and related material for the *Falcon* missile.

$1,300,000—**Pax Electronics Co., Inc.**, Woodside, N.Y., for manufacture of a photographic shelter.

$1,202,586—**North American Aviation, Inc.**, El Segundo, Calif., for work on the *Hound Dog* missile (supplemental contract). Work to be done at Downey, Calif.

$1,000,000—**Acoustica Associates, Inc.**, Los Angeles, for production of propellant utilization systems for the *Atlas* missile.

$525,000—**Collins Radio Co.**, Dallas for a microwave system from Cape Canaveral to the Malabar Airport and terminating at Valkar, Fla., on the Atlantic Missile Range.

$500,000—**International Electric Corp.**, Paramus, N.J., for a Range Instrumentation Planning Study (RIPS).

ARMY

$34,324,226—**Raytheon Co.**, Lexington, Mass., for *Hawk* missile guidance and control system. Work to be done at Andover, Mass.

$19,896,130—**Western Electric Co.**, New York City, for continued development of an advanced radar designed for possible future incorporation into the *Nike-Zeus* antimissile system.

$19,409,630—**Bendix Corp.**, Detroit, for *Pershing* missile guidance and control components and ground support equipment. Work to be done at Teterboro, N.J.

$6,168,940—**Western Electric Co.**, New York City, for *Nike-Hercules* ground guidance and control equipment. Work to be done at Greensboro, N.C., and Steel Products Co., Springfield, Ohio.

$5,706,421—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for *Nike-Hercules* airframes. Work to be done at Charlotte, N.C.

$4,933,282—**Land-Air, Inc.,** Chicago, for collection of missile in-flight data.

$3,399,020—**Radio Corp. of America,** Moorestown, N.J., for continuation of down-range antimissile measurement program for 1963.

$2,100,000—**Radio Corp. of America's Defense Electronic Products Div.,** Camden, N.J., for continued performance leading to development of multi-system test equipment.

$2,021,823—**Telecomputing Services, Inc.,** Panoroma City, Calif., for data reduction services at White Sands Missile Range.

$1,523,808—**Curtiss-Wright Corp.,** Wood-Ridge, N.J., for *Pershing* missile equipment.

$1,169,321—**Land-Air, Inc.,** Chicago, for range instrumentation at White Sands Missile Range, N.M.

$75,000—**Allegany Instrument Co.,** Cumberland, Md., for a Type K-6 Ballistic Computer which records and displays ballistic parameters sensed by strain gage transducers during static firing of solid-fuel rockets.

NAVY

$55,394,747—**Raytheon Co.,** Lexington, Mass., for work on *Sparrow III* guided missiles.

$36,000,000—**General Dynamics/Pomona,** Pomona, Calif., for continued production of *Tartar* and advanced *Terrier* guided missiles.

$1,700,000—**General Electric Co.,** New York City, for classified communications equipment. Work to be done at Oklahoma City.

$1,097,000—**Sperry Rand Corp.'s Sperry Gyroscope Co.** division, Great Neck, N.Y., for field engineering services on *Terrier* and *Talos* missiles.

$1,073,842—**Electronic Specialty Co.,** Los Angeles, for a transit satellite injection station at Rosemont, Minn.

$500,000—**Columbia Broadcasting System, Inc., CBS Laboratories,** Stamford, Conn., for development of an advanced high-resolution aerial reconnaissance and surveillance system.

$105,000—**Vitro Corp.,** Silver Spring, Md., for engineering services in the field of measurement science. Work to be done at the Naval Weapons Industrial Reserve Plant at Pomona, Calif.

NASA

$5,500,000—**Edgerton, Germeshausen & Grier Inc.,** Boston, for design procurement, installation and checkout of instrumentation and control systems for Engine Test Stand No. 1 at the Nuclear Rocket Development Station (NRDS).

$2,162,000—**Raytheon Co.,** Lexington, Mass., for work on the *Apollo* Moon vehicle computer.

$91,609—**Wilmot Castle Co.,** Rochester, N.Y., for studying methods of sterilizing space probe components.

$67,800—**Martin Marietta Co.,** Baltimore, for conducting a feasibility study for a two-body mid-course guidance system for lunar missions.

INDUSTRY

$1,000,000—**General Precision Inc.'s Link Div.,** Binghamton, N.Y. from **McDonnell Aircraft,** for two computers to be used on *Gemini* space mission trainers.

$600,000—**Jefferson Electronics, Inc.,** Santa Barbara, Calif., from the **Boeing Co.'s Aero-Space Div.,** for custom cable and electronic "black box" assemblies to be used as part of the ground support equipment for the operational *Minuteman* underground silos.

$460,000—**Century Electronics and Instruments, Inc.,** Tulsa, Okla., from the **Boeing Co.,** for work performed beyond the scope of the original contract under which Century designed and built telemetry calibration carts for the *Minuteman* missile program.

$200,000—**Rixon Electronics, Inc.,** Silver Spring, Md., from the **Philco Corp.'s Western Development Laboratories,** for supplying SEBIT-24B data transceivers for use in a satellite tracking system.

$80,000—**Raytheon Co.,** Lexington, Mass., from the **Boeing Co.'s Aerospace Div.,** for NPN diffused silicon planar transistors similar to the 2N1613 type.

The Deutsch Co.'s Electronic Components Div., Banning, Calif., from **Lockheed Missiles and Space Div.,** for a miniature connector high-reliability test and qualification program for space systems applications on Air Force vehicles (undisclosed amount).

Planning Research Corp., Los Angeles, from **Jet Propulsion Laboratory,** for continuation of system reliability studies of the *Mariner* planetary spacecraft. (undisclosed amount).

National Research Corp., Cambridge, Mass., from **Pratt & Whitney Aircraft,** for advanced space simulation testing of rocket engine components for the *Saturn* second stage.

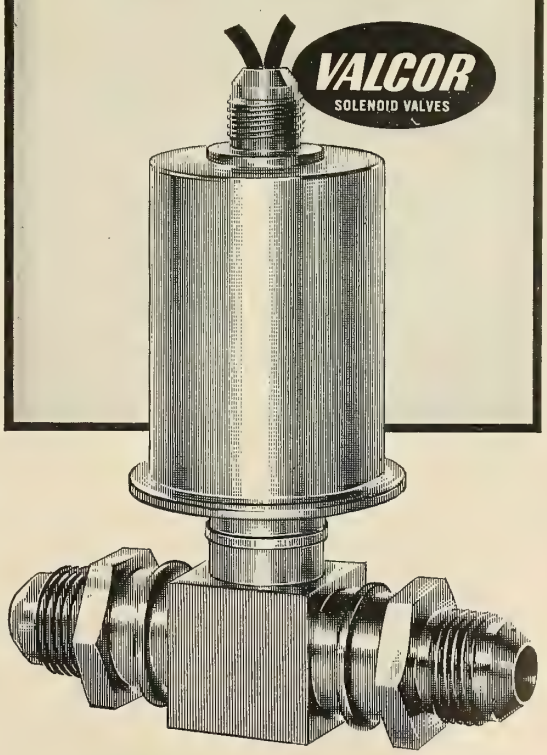
A solenoid valve that operates at −423°F or 1000°F

Valcor's engineers originally designed this solenoid valve, of series 412, to operate completely submerged in liquid hydrogen (—423°F). The unique application required a valve that would eliminate the use of any non-metallic parts coming in contact with the media, internal or external. All materials had to be critically analyzed because of the destructive forces inherent in such extreme temperatures.

The all welded construction, which Valcor has developed to a new state-of-the-art, helped resolve many of the problems. During the exhaustive series of tests, it was known that many of the problems in operating a solenoid valve under the extremes of low temperature had a correlation to problems created by high temperatures. The result — a **one** valve concept that with minor variations could be used for high or low temperatures...

Another reason why Valcor precision engineered valves are chosen for so many aero-space vehicles.

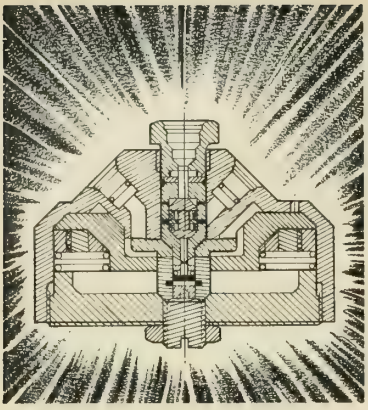
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The Model 4890 Pressure Regulator (illustrated above) is a single-stage, pilot-operated device intended to control pressure in a gas-filled reservoir.

Advanced design features include: (1) All valve poppets and seats are metal; (2) No dynamic, leak-tight seals are required other than a metal diaphragm; (3) No sliding seals, rubber gaskets or rubber diaphragms are used; (4) No lubrication is required.

Operational Data — Regulated pressure range: **100** to **300** psig. Regulated pressure tolerance: **±2 percent** with inlet pressure to **500 psig; ±4 percent** over full inlet pressure range. Inlet pressure range: **325** to **3500 psig.** Flow rate: **0.025** pounds per second of nitrogen at **100 psig** and **80°F.** Temperature range: **—325°F.** to **+300°F.** Vibration range: **0-2000** cps at **65 g's.**

The Model 4890 has the following important advantages over conventional regulator designs: (1) Relatively small for a unit with its capacity and capability; (2) No vibration damping devices used, thus permitting use of very minimum number of parts. This provides high degree of reliability; (3) Simple temperature compensation system minimizes set point drift . . . providing wide usable temperature range.

This basic design is adaptable to many applications.

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book reviews

ADVANCES IN ASTRONAUTICAL PROPULSION, edited by Corrado Casci. Pergamon Press Ltd., New York City. 394 pp., $14.

Author Casci provides 15 technical papers, most of them written by well known scientists in the propulsion and astronautical fields. Many fundamental concepts in the astronautical sciences are explained by the men who devised them.

The papers—first given nearly two years ago—comprise the proceedings of a seminar held in Milan by Istituto Lombardo Accademia di Scienze e Lettre in collaboration with the NATO Advisory Group for Aeronautical Research and Development.

Among the authors and their papers: Luigi Crocco, "Meccanica della Propulsione Spaziale"; Martin Summerfield, "Physico-Chemical Problems Related to Solid Propellant Propulsion"; S. S. Penner and Louis L. Bixson, "Horizons in Liquid-Propellant Rocket Propulsion"; E. Saenger, "Nuclear Rockets in Space Flight"; Robert W. Bussard, "Nuclear Fission Rockets—Problems, Progress and Promise"; Antonio Ferri, "The Re-entry from Space Flight into the Earth's Atmosphere"; Luigi Broglio, "Requisiti per la Propulsione e la Guida su Traiettorie Aerospaziala"; and Paul Libby, "A Survey of Heat Transfer Problems connected with Space Vehicle Re-entry."

MECHANICS OF FLUIDS, Irving H. Shames. McGraw-Hill Book Co., New York City. 555 pp., $8.95.

Here is a rigorous fundamental text on fluid mechanics. The book is designed as a first course in science-oriented engineering programs. Though theory is stressed, an ample number of practical problems is given both in illustrative examples and as exercises.

The author terms the book "a vector treatment of fluid flow." It is a highly recommended text, of value to practicing engineers, as well as students.

SHOCK TUBES, J. K. Wright. John Wiley & Sons, Inc., New York City. 164 pp., $2.95.

One of a series of monographs, this book describes the principles of operation and use of shock tubes. An elementary survey of basic concepts in plasma physics is also included.

Wright offers the reader a simple exposition of shock wave theory, shock wave reflection, refraction and diffraction in a style easy to follow.

SYSTEMS ENGINEERING MATHEMATICS, J. Eugene Alexander and J. Milton Bailey. Prentice-Hall, Inc., Englewood Cliffs, N. J. 394 pp., $13.

The relatively new field of systems design calls for engineers and scientists familiar with a variety of disciplines. This book emphasizes common principles of mathematics involved in elementary physical problems of electrical, mechanical, fluid and thermodynamic engineering.

Engineering Manager: Space Environment Laboratory

A major defense and space systems manufacturer has an immediate engineering management opening on the West Coast. The person selected will be responsible for the concept, design, performance and operation of a new space environment laboratory.

To qualify you must have experience related to the specification, design, construction liaison and operation of a space environment laboratory. Knowledge of solar simulation and ultra-high vacuum techniques is highly desirable. Salary is open.

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New Product of the Week: Ionization Chamber

An advanced ionization chamber designed for automatic, remote measurement of ionizing radiation flux is available from Electro-Optical Systems, Inc.

Developed originally for use on spacecraft, it has been subjected to extensive operational tests, simulated rocket launch environments, and actual space flights. It can be used in a wide range of environments for accurate and continuous monitoring without adjustment or maintenance.

Designated Model No. IC-5, 1962, the instrument is sensitive to radiation from any direction over a wide dynamic operating range. Its output signal, consisting of pulses at a frequency proportional to incident flux, can vary from one pulse in seven hours to 100/second —equivalent to a flux range from 0.01 mr to 50 R/hr. The chamber wall permits passage of alpha particles of 40 mev or more, beta particles equal to or greater than 0.5 mev, protons of 10 mev and above, and all gamma rays.

The only moving part is a quartz



fiber capable of surviving a minimum of 10 million pulses. The instrument tolerates temperatures from −50°C to 150°C, vibration up to 5-g sine wave along any axis, shock up to 200 g of 3-4 millisecond duration, and accelerations up to 5 g in any direction.

Circle No. 225 on Subscriber Service Card

Ultrasonic Cleaning Unit

A five-gallon ultrasonic cleaning console has been developed by the Dynasonics Corp. for use where exceptional cleaning results are required.

Powered by a 300-watt generator, the Model 1500 console uses an extremely fast-drying freon solvent in a highly efficient ultrasonic cleaner. Because freon is non-toxic, non-explosive and non-flammable, it cannot harm the operator in any way. In addition, its quick-drying properties prevent dragout or residual blemishes.

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Ultra-High-Temp Furnace

Electron Heating Corp. offers a tensile and creep-test furnace capable of heating specimens, prototype rocket nozzles, and other large objects to 6000°F or more. The electron beam equipment will uniformly heat the target to the desired temperature and maintain set point for extended periods of time. Heating rates, duration and set point can be easily controlled.

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TO MEN WHO CAN LOOK DEEP INTO TOMORROW

Top echelon positions are open to men with vision at Bell Aerosystems Co. This growing organization today needs *more* senior scientists and engineers who can perceive where technology should go to meet tomorrow's aerospace requirements — and lead the way to advances beyond the existing state-of-the-art.

Vision coupled with sound engineering judgment has always been characteristic of this Company, as exemplified by such achievements as:

- The AGENA Rocket Engine, workhorse of the space age, proven most reliable on a variety of satellite and space probe launches for the USAF and NASA
- Reaction controls for Mercury and other space vehicles
- The FIRST Rocket Belt for man in free flight

SENIOR POSITIONS ARE NOW OPEN IN:

ROCKET DEVELOPMENT
To conduct analytical and design studies and investigations in all areas of liquid propellant engines and systems; perform conceptual design and supporting analyses for new rocket propulsion devices.

ROCKET SYSTEMS
Analysis for propulsion systems of interrelated effects of system configuration changes, cumulative controlled tolerances of components, thermal variations, hardware interchangeability and dynamic conditions on gas storage requirements, and system steady state and transient performance.

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A-c signals as low as 20 microvolts, emerging from small transducers and other high-impedance signal sources can be measured without capacitive or resistive circuit loading with any Electrometer developed by Micronia Amplifier Corp. The unit consists of a low-gain (6 db) field-effect transistor preamplifier and a high-gain (74 db) junc-



tion transistor post-amplifier. Resistive and capacitive input loadings are eliminated by a specially selected field-effect transistor whose high input impedance (100 meg, 4 pF) is further increased by negative feedback to several thousand megohms and less than 1 pF. Small, adjustable amounts of regenerative feedback finally make input resistance infinite, and input capacity zero.

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PNP Transistor

The AC107, a germanium PNP transistor having extremely low noise characteristics and specifically designed for magnetic tape head pre-amplifiers, is being marketed by Amperes Electronic Corp. Instead of measuring noise under arbitrary conditions and at a single arbitrary frequency, the noise figure for the unit is based on measurements over the entire audio bandwidth, which duplicates the actual conditions under which the transistor will operate in practical applications. So measured, the AC107 has a typical noise figure of only 3 db from 30 to 15,000 cps (Vce-4V, Ic-0.3 ma; Rs-1500 ohms).

Circle No. 229 on Subscriber Service Card

UHV Diffusion Pumps

A series of diffusion pumps, designed for special ultra-high chambers used in solid-state and space-simulation projects, is being marketed by NRC Equipment Corp., a subsidiary of National Research Corp. Pumps are available in 4, 6, and 10-in. sizes. They allow good flexibility in sealing. Also, the pumps can be used with the newest fluids that do not crack, and contribute significant amounts of hydrocarbons to the vacuum systems.

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PCM Signal Conditioner

A PCM signal conditioner developed by Dynatronics, Inc., provides a complete ground station for collecting and displaying PCM telemetry data. The Model 5228 system accepts serial PCP inputs in NRZ, RZ, or split-phase form from a tape playback driver, receiver, integral signal simulator, or other external source. Output is regenerated noise-free parallel and serial PCM data, and four phases of sequential timing pulses phase-locked to the incoming bit-rate frequency. The all solid-state system provides bit synchronization at extremely low S/N ratios and over wide bit-rate ranges (10-640,000 bits/sec.). A special feature is the integral check-out circuitry, which provides quick and easy self-check of the conditioner and decom chassis and checkout of the receiver.

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Lift Electric Hoist

A long-lift, explosion-proof electric hoist specially designed for missile handling applications is available from Detroit Hoist & Machine Co. The unit is a special adaptation of the company's Type HR electric hoists, has a 24-in. dia. drum that provides a lift of 125 ft. A two-speed motor provides hoisting speeds of 10 and 2½ fpm.

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Refractory Alloy

Westinghouse Electric Corp. has developed a tantalum base alloy with properties superior to those of other refractory metals for many uses, particularly space applications. The alloy, designated T-111, has a composition of 8% tungsten, 2% hafnium, balance tantalum. Main features are relative ease of fabrication, weldability, and moderate-to-high strength at elevated temperatures.

Extrusion is not required to produce useful shapes of T-111; as-cast ingots can be forged at temperatures as low as 2000°F. The alloy exhibits strength above 3000°F and down to −452°F.

Circle No. 233 on Subscriber Service Card

Automatic Sorter

A completely automatic system for measuring and sorting silicon diode pellets by voltage and current characteristics has been developed by Techni-Rite Electronics.

The system accepts pellets in bulk, feeds them automatically to the measuring station and positions them under an electrical measuring probe. The cam-



actuated probe contacts each pellet individually and determines its polarity. Forward voltage and reverse current tests are made and the pellets are sorted into acceptable or non-acceptable categories. A re-inspection category may also be used for shorted or open-circuited pellets. Sorting rate is 1800 pellets per hour.

Circle No. 234 on Subscriber Service Card

Heat-Resisting Unit

Two aluminum-filled epoxies have been developed by Marblette for heat-resistant tooling and for castings with thick sections.

Maraset #618 achieves a heat distortion point above 550°F and can be cast or laminated for accurate, dimensionally stable tools and dies for operations where elevated temperatures are to be encountered. The units provide good heat dissipation, and toughness and flexural strength are maintained over a wide operating range with a low coefficient of expansion. The resin can be mixed with either a low melt hardener, or for less critical applications, a liquid hardener. Heated molds and baked-temperature cycles of 200°F, 300°F and 400°F are recommended for casting and curing.

Circle No. 235 on Subscriber Service Card

Drill Starter Guides

Morey Products Co. is marketing a series of drill starter guides up to bit sizes of 4 in. The guides eliminate the need for specially made wooden templates, attachable starter points and the repeated sharpening of these points. A pocket-size precision guide covering bits up to 1.5 in. is available. A firm pressure holds the guides on any material. The units are on the Federal Supply Schedule, FSC Groups 51 and 52, Contract No. GS-OOS-37652.

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Ultraminiature Contacts

Electrical contacts in diameters as small as 0.062-in. are being marketed by Mallory Metallurgical Co., a division of P. R. Mallory & Co., Inc. The smallest contacts available on a production basis, they are made of a silver-gold alloy—Elkonium 72. The contacts are expected to meet the needs of the electronics industry in many devices, as efforts to miniaturize products restricts the size of components.

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NDRO Memory Transfluxor

A two-hole transfluxor for coincident current non-destructive memory applications is available from Electronic Memories, Inc.

The "shmoo" shape of the transfluxor gives excellent electrical characteristics, such that in the saturated state for "read" or "write" the unsaturated area of the transfluxor is very small. The shmoo shape also provides simplified orientation of "read and write" holes during automatic grading.

The physical and electrical characteristics of the "read" hole of the transfluxor can be matched with those of a standard 50 mil toroid, allowing a design of a non-destructive coincident current memory and a destructive read "scratch pad" memory using the same drive-circuitry design. The transfluxor has been successfully tested in coincident current operation over a temperature range of 0°C to 70°C with compensated drive currents.

Circle No. 238 on Subscriber Service Card

Sensor Unit

Perkin Electronics Corp. is marketing a sensor unit with two separate detection channels—one for overvoltage and one for undervoltage. Each channel consists of a voltage-sensitive bridge, using a silicon zener diode as a reference.

The unit is available in two different forms: an open type, normally incorporated in circuits where space is available within a power supply; and a basic closed type, used as modular "black box," internally or externally from a system. The device is designed for laboratory applications, as it operates from a 115-v, single-phase, 60-cycle a-c input instead of the 26-v center-tap a-c input used by the open-and-closed type without the CI assembly.

Circle No. 239 on Subscriber Service Card

Commutator

Available from International Data Systems, Inc., the Model 3-12 is a small transformer-coupled commutator for 30-x10 configurations. Designed for space requirements, the 3-12 registers less than 0.25 uA back-current at 85°C. The unit employs back-to-back transformer-driven transistor switches. PAM wave train conforms with the IRIG Standard for signal input ranges for 0 to 1v. or 0 to 5v. Other features are: offset voltage, 2 mv maximum; overload protection, ±15 v; linearity, 1 mv. Reverse current at 85°C on any channel is less than 0.25 microamperes with all other channels at 5 v. In addition, provisions for external clock and frame synchronization are provided.

Circle No. 240 on Subscriber Service Card

Corrosive Service Valve

A corrosive-service valve for handling UMDH, N_2O_2 and other highly reactive fluids is available in manual and remotely controlled types from Flodyne Controls, Inc. This valve is



designed with full-line size, straight-through flow, and zero leakage at pressures from 150 to 600 psi. Sizes range from ¼ to 10-in.

Circle No. 241 on Subscriber Service Card

Statistical Accelerometer

A statistical accelerometer that provides a complete history of acceleration forces exerted upon a vehicle or system is available from Maxson Electronics Corp.

The Model 262 is an ultrasensitive device designed to sense several preset g levels and record them on a four-channel statistical recorder. It can be used to forecast structural reliability based on predetermined operational stress loads. The device is comprised of the Model 200 multi-level acceleration transducer for sensing accelerations from from one g to 10 g, and the Model 210 direct-reading, statistical indicator for recording up to four different steady-state occurances.

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Noise Source Tube

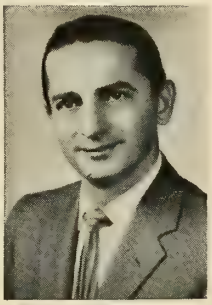
A compact, broadband, permanent magnet, focus noise source tube has been developed by Warnecke Electron Tubes, Inc. Type RW-100 generates a minimum of 1 watt noise power. The total band between 50 kc and 200 mc can be covered by this low-frequency tube. Since the tube functions as a constant current generator, any smaller frequency band within the total band can be selected by using suitable external filters while maintaining the same integrated noise power output. The tube is forced-air cooled, and is furnished with standard socket HX29 mounting and standard 50 ohm BNC coax output connector. Tube life is projected at 1000 hrs.

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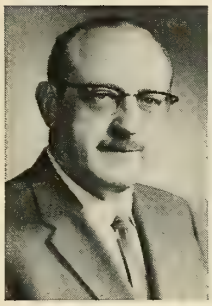
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Andre W. Reichel: Appointed manager of the Western Region for Radio Corp. of America's Defense Electronic Products Group, Los Angeles.

Dr. Janis Galejs: Appointed senior scientist at the Applied Research Laboratory of Sylvania Electric Products, Inc., Waltham, Mass.

Herbert W. Pollack: Appointed president of the newly formed Polarad Electronic Instruments Div., of Polarad Electronics Corp., Long Island City, N.Y. **Frank J. Skwarek** named corporate vice president and president of the newly formed Radiometrics Div.

Richard H. Foy: Named director of systems engineering and integration for Lear Siegler, Inc.'s Space Systems Center, Santa Monica, Calif.

Bernard Edelman: Named Western regional manager for the Customer Engineering Dept. of Epsco, Inc.'s Systems Div., Cambridge, Mass.

Richard E. Wizniak: Elected secretary-treasurer of the C. E. Johansson Gage Co., Dearborn, Mich.

Thomas M. Trainor: Named manager of a systems project group in the Systems Enginering Dept. of the Government Products Div., Adler Electronics, Inc., New Rochelle, N.Y.

Earl L. Clemick: Appointed marketing manager, Ceramic Products for Centralab, the Electronics Div. of Glove-Union, Inc., Milwaukee. **Mark Williams** appointed PEC sales manager.

Ernest L. Perry, Jr.: Joined Atlas Chemical Industries, Inc.'s Aerospace Components Div., Wilmington, Del., as chief methods engineer.

David D. Coffin: Elected a vice president of Sanders Associates, Inc., Nashua, N.H.

William R. Ramsay: Named a senior member of the Electronics Sciences Laboratory of Lockheed Missiles & Space Co., Sunnyvale, Calif. **Allen S. Dunbar** appointed a consultant.

Dr. Bernard Keisch: Appointed senior scientist at Nuclear Science and Engineering Corp., Pittsburgh.

Ralph R. Ragan: Named manager of Raytheon Co.'s Sudbury, Mass., operation in its Missile and Space Div.

Hideo Ihara: Appointed director, Electromagnetic Warfare Dept. of White Electromagnetics, Inc., Bethesda, Md.

William R. Adam: Named director of advertising and public relations for the UNIVAC Div. of Sperry Rand Corp., New York City.

John A. Bernardini: Appointed sales manager of Optical Gaging Products, Inc., Rochester, N.Y.

Henry E. Bowes: Elected a vice president of International Telephone and Telegraph Corp. and director of defense relations, Washington, D.C.

Jerry H. Werlin: Appointed product manager-digital systems, Canoga Electronics Corp., Van Nuys, Calif.

Dr. Lester C. Van Atta: Named chief scientist of Lockheed Missiles and Space Co., Sunnyvale, Calif.

Peter N. Dudeney: Joined the Research and Engineering Dept. of Baird-Atomic, Inc., Cambridge, Mass.

Dr. Bernard Murphy: Appointed vice president-international operations for Electronic Associates, Inc., Long Branch, N.J.

H. Lane Dudley: Appointed president of Control Science Corp., Alexandria, Va.

John J. Rowlette: Appointed supervisor of the Fuel Cell Laboratory in the Advanced Power Systems Div. of Electro-Optical Systems, Inc., Pasadena, Calif.

Dr. James C. Fletcher: Elected vice president-advanced systems of Aerojet-General Corp., Azusa, Calif.

Malcolm W. Boyd: Joined the public relations staff of United Technology Center, Sunnyvale, Calif.

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Edward I. Espy: Appointed resident manager, industrial systems, Consolidated Systems Corp.'s Washington, D.C., office.

Al M. Carnesciali: Joined Electro-Optical Systems, Inc., Pasadena, Calif., as manager of contract administration.

William F. Eicher: Named manager of Hughes Aircraft Co.'s aerospace group research and development division, Culver City, Calif.

John H. Carter: Elected president and chief executive officer of Allied Research Associates, Inc., Concord, Mass.

Eamonn D. A. Geoghegan: Elected engineering vice president of Dearborn Electronic Laboratories, Inc., Orlando, Fla.

Robert H. Bliss: Named general manager of United Shoe Machinery Corp.'s Harmonic Drive Div., Boston, Mass.

Robert O. Maze: Appointed director of engineering for Minneapolis-Honeywell Regulator Co.'s Ordnance Div., Minneapolis.

Edward F. Mullen: Appointed application manager for the Berkeley, Calif., Div. of Beckman Instruments, Inc.

John A. Webb: Elected vice president for marketing of Bentley-Harris Manufacturing Co., Conshohocken, Pa.

Alvin B. Phillips: Promoted to manager of Integrated Circuits Operations at Motorola's Semiconductor Products Div., Phoenix, Ariz. **George Scalise** promoted to product manager, Hybrid Integrated Circuits and **Dwayne King,** product manager, Monolithic Integrated Circuits.

John C. Lindley: Appointed vice president of Litton Systems and director of marketing of the Data Systems Div., Beverly Hills, Calif.

Edward R. Bulkeley: Elected vice president, administration, of Hart Manufacturing Co., Hartford, Conn.

James E. Mills, Jr.: Appointed manager of sales for the St. Petersburg, Fla., division of Electronic Communications, Inc.

Peter V. Ricciardi: Appointed vice president and sales manager of National Ultrasonic Corp., Somerville, N.J.

Richard L. Colten: Appointed manager of industrial television sales at Du Mont Laboratories divisions of Fairchild Camera and Instrument Corp., Clifton, N.J.

Hart Perry: Elected treasurer of International Telephone and Telegraph Co., New York City.

George A. Strichman: Named president of Fairbanks, Morse & Co. subsidiary of Fairbanks Whitney, New York. **David I. Margolis** named financial vice president and treasurer of Fairbanks Whitney Corp.

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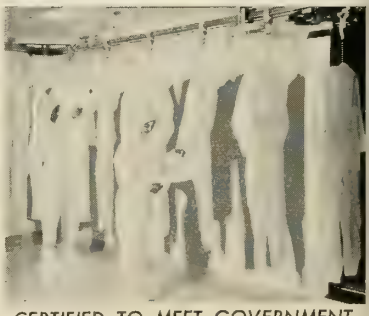
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JANUARY

Automotive Engineering Congress and Exposition Society of Automotive Engineers, Cobo Hall, Detroit, Jan. 14-18.

Ninth Annual American Astronautical Society Meeting, Statler Hilton Hotel, Los Angeles, Jan. 15-17.

31st Annual Meeting, Institute of the Aerospace Sciences, Hotel Astor, New York City, Jan. 21-23.

43rd Annual Meeting, American Meteorological Society, New York City, Jan. 21-24.

Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

The Third Symposium on Naval Structural Mechanics, Columbia University, New York City, Jan. 23-25.

Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn., International Inn, Washington, D.C., Jan. 28.

Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

FEBRUARY

Evolutionary Operations Course, Chemical and Food & Allied Industry Divs., American Society for Quality Control, San Francisco, Calif., Feb. 1-2.

Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Feb. 5-6.

Electronic Sales-Marketing Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques, UNESCO Building, Paris, Feb. 11-15.

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The Soviet Threat

EVER SINCE the end of World War II, the U.S. has sneered at the technical potential of the Soviet Union in one area after another—and has been proven wrong in almost every specific instance.

We can remember the testimony of experts who insisted that the Russians did not have the technical ability to build an atomic bomb. We then were told they did not have the industrial capacity to produce an H-bomb. We were assured by some of the brightest people in the land that the Soviets could not build intercontinental ballistic missiles. The idea of a successful Russian space program was laughed at by many.

There were articles in learned journals proving that *Sputnik I* was a hoax. The Soviet photos of the back side of the Moon were a "fake." More recently, a national columnist explained to his readers that the *Vostok III* and *IV* flights might have been an elaborate deception.

Because the Russians wear baggy suits, lack comfortable split-level suburban homes and do not drive air-conditioned automobiles, many have scoffed at them as peasants incapable of achieving scientific and technical competence. Because they suffer from terribly crowded housing conditions, crumbling apartment construction and a generally low standard of living, it has been assumed that the Soviets lack an industrial capacity to match ours.

It is precisely because of their lack of such conveniences as automobiles and uncrowded housing that the Russians are formidable opponents. Autos could divert scarce steel from missile and space programs; housing could divert badly needed building materials from industrial construction projects.

A large percentage of the Soviet gross national product is going into establishment of basic industries—the industries needed by a modern industrial nation. Much of our national product today is wasted on luxuries, so much so that Americans easily forget that our own labor force also was exploited while our basic industries were established. Immigrant laborers from Poland, Ireland, Italy and other nations worked under abominable conditions in the coal mines and sweat shops while the fruit of their labor went into forming the industrial complex which today is the heart of this nation. There was a similar exploitation of labor in Great Britain during the Industrial Revolution.

The Soviet Union now is in this same stage of national development—and moving through it at a rapid pace. The fact that it is being accomplished under a Communist form of government makes it no less of a fact. This, indeed, makes it easier to direct development into the areas which the Soviet leaders consider important.

To underestimate the extent of the Soviet accomplishment is to underestimate the enemy, an error which can be fatal. The Soviets are a determined people with a clearly-defined national objective—that of overtaking and surpassing the United States in every area of accomplishment.

Whether they succeed depends as much upon our efforts as upon theirs. If we stand still, they will pass us.

This somewhat broad discourse has a significant and narrow point for the missile/space industry. The school of thought which informs us that the Russians are "incapable" still is very much with us.

The most recent example is the report on the Soviet economy which was released by the Congressional Joint Economic Committee. This survey consists of a series of papers prepared by "experts" in Soviet affairs. We covered the report last week.

The gist of the report—which could seriously affect U.S. procurement in the missile/space field if taken seriously—is that the Soviet economy cannot support an ICBM program, a missile defense program and a space program simultaneously.

THIS IS SO MUCH academic hogwash.

If the Russians decide all three programs are imperative to their national objectives, we are confident of their ability to support all three.

It is quite possible the Soviet Union may decide that one, or even two, of these programs can be bypassed in favor of concentration on the third. Perhaps the Soviets will find that the three objectives can be attained in a single program—the space program.

The Soviet leaders may decide—or may already have decided—that a stretchout is desirable in one area or another while the third is speeded.

These, however, are questions of intention and decision. If we delude ourselves into thinking that the capability to accomplish all three does not exist, we may be in for a rude shock.

If we decide not to build anti-ICBM defensive weapons, for example, due to a belief that the Soviets are incapable of building ICBM's while simultaneously developing missile defenses of their own, we may not survive as a nation to regret our mistake.

There is no surer path to our own destruction than to underestimate our opponent. Yet we consistently have been doing that for almost two decades. The Congressional report is evidence that we are continuing to do so.

The committee's survey tells us that the nature of the Soviet planned economy is such that breakthroughs must be predictable as far as 20 years in advance. It is asserted that if they cannot be worked into the master plan this far in advance it will be totally disrupted every time a new technological development appears.

Anyone who honestly believes such a statement is so blind to the Soviet record of recent years that he is giving aid and comfort to the enemy.

The taxpayer's dollar should be spent on programs to meet the quite real Soviet threat—not on idiotic academic treatises devoted to disparaging it.

William J. Coughlin

this barrel delivers hydraulic firepower to the F-104

You're looking at the muzzles of the hydraulic pump in use on all the world's second generation F-104 aircraft — the first combat aircraft to become a *standard* among free nations. ■ Equal to the international scope of the F-104, American Brake Shoe's reliable Kellogg AP10V-13 pumps used in the aircraft's flight control and utility systems are manufactured by subsidiaries in Canada and Europe — as well as at the Aerospace Division in Oxnard, California. ■ In Canada, Brake Shoe's Jarry Hydraulics Ltd. also manufactures horizontal stabilization servo assemblies and aileron servo assemblies for the F-104. ■ Whatever the scope of your electro-hydraulic problem, call on the Aerospace Division, 3151 West Fifth Street, Oxnard, California.

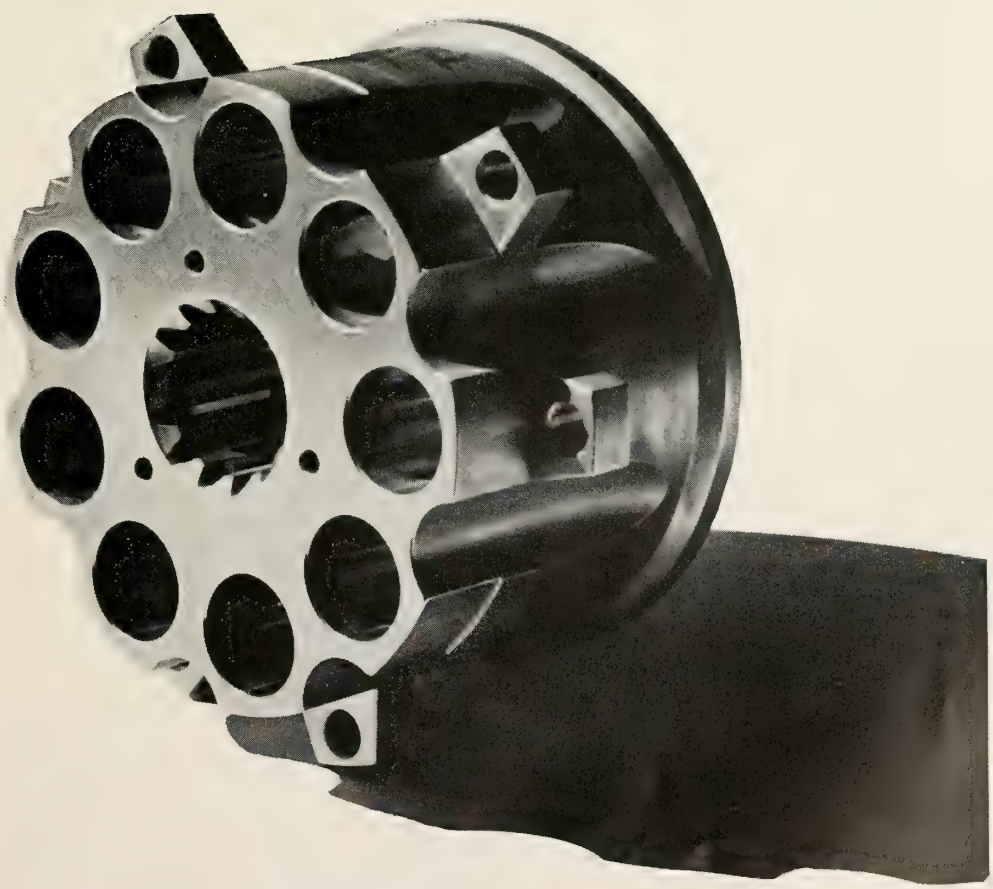
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JANUARY 21, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

JAN 1963 PUBLIC

FOR RELEASE AT 12 NOON (E.S.T.) THURSDAY, JANUARY 17, 1963

NOTICE: There should be no premature release of this Budget nor should any of its contents be paraphrased, alluded to, or hinted at in earlier stories. There is a total embargo on this Budget until 12 noon, January 17, 1963, which includes any and all references to any material in the Budget or the Budget Appendix.

PIERRE SALINGER,
Press Secretary to the President.

THE BUDGET

OF THE UNITED STATES GOVERNMENT

FISCAL YEAR ENDING JUNE 30 1964

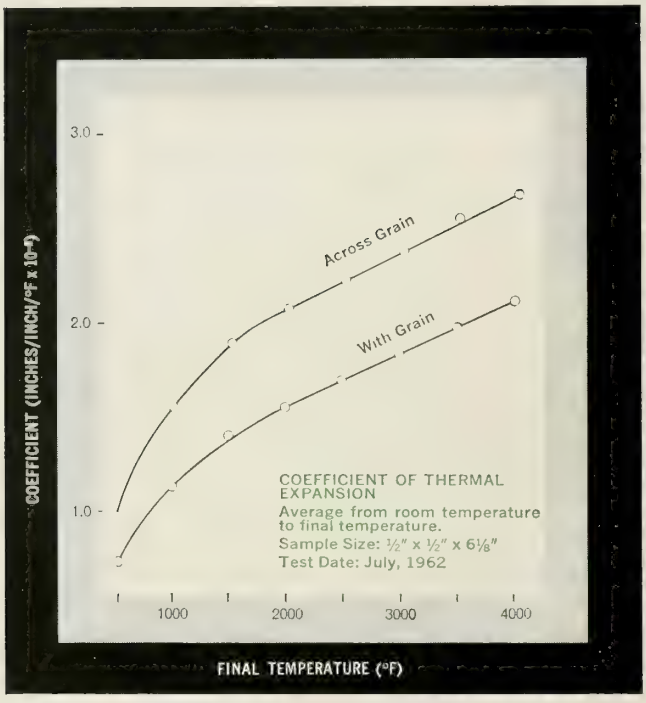
Budget Asks $18 Billion+ For Missiles and Space

- **Centaur Given Top Priority**
- **R&D Indicates Asbestos Uses**
- **Chart Shows Cislunar Nature**

Cover of FY '64 Budget

AHDG

high-performance GRAPHITE



COEFFICIENT OF THERMAL EXPANSION AHDG is an extruded base high density graphite (1.90 gm/cc minimum) processed for maximum thermal shock resistance and exceptional physical properties. The above plot of thermal expansion vs. temperature supersedes previously published data, and illustrates our continuing program of product evaluation and improvement. ☛ American Metal Products Company supplies AHDG high-performance graphite in bulk or fabricated to customer specifications. For complete information on AHDG or the fabrication of this high-performance graphite, write or wire the Research Division, 2601 South State Street, Ann Arbor, Michigan.

NO. 7 IN A SERIES OF DATA SHEETS ON HIGH-PERFORMANCE GRAPHITE

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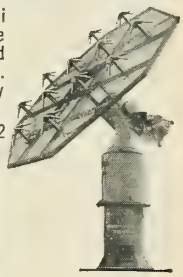
RESEARCH DIVISION / 2601 SOUTH STATE STREET / ANN ARBOR, MICHIGAN

Circle No. 4 on Subscriber Service Card

GEMINI TRACKING SYSTEM

canoga

NASA's Goddard Space Flight Center, Greenbelt, Md., selected Canoga's new TELTRAC systems to acquire and track the Gemini vehicle as it comes over the horizon, aim the primary tracking radar and receive telemetry data. TELTRAC, a complete passive telemetry tracking system, containing a new crossed dipole antenna array, an updated standard Canoga pedestal system, and a monopulse tracking receiver, is one of a number of instrumentation range tracking systems designed and manufactured by Canoga. It will supplement the Project Mercury tracking systems with a more up-to-date system capable of acquiring and tracking any IRIG telemetry signal within the range from 215 to 260 mc/s.

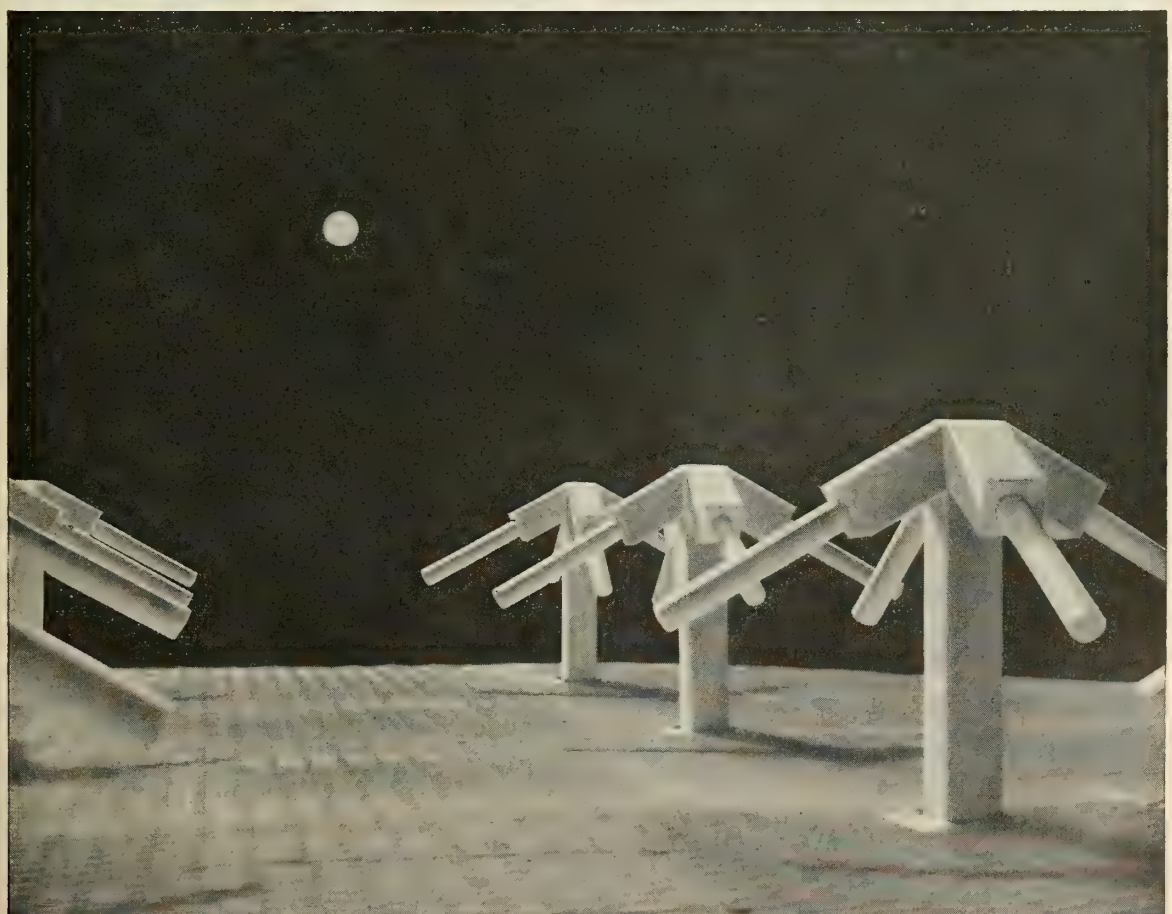


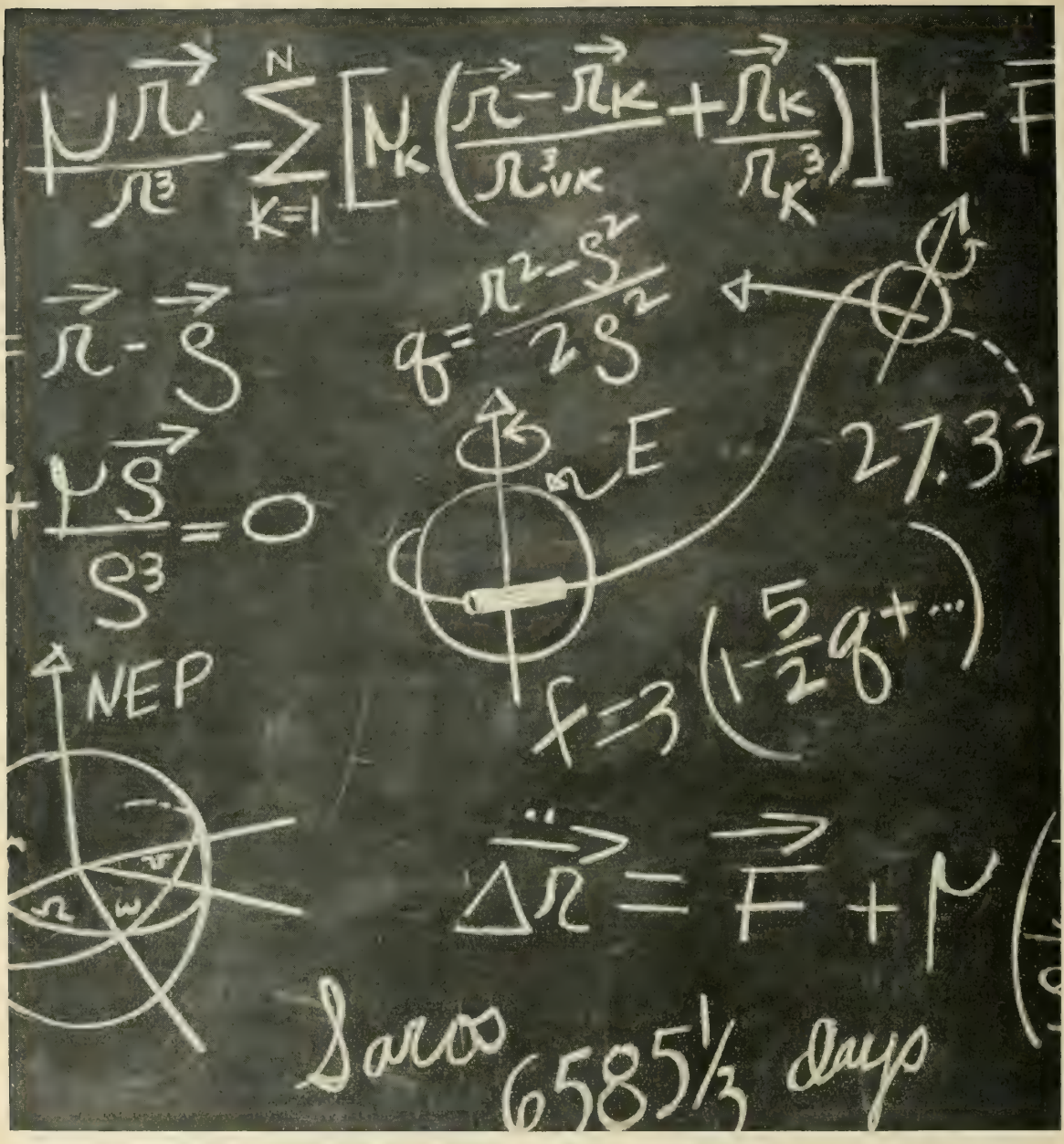
Of particular interest in this new TELTRAC system is the TELAR antenna developed by Canoga. This unique array comprising 12 crossed dipole elements on a 13-foot octagonal ground screen, can be remotely switched to horizonal, vertical, LH, or RH circular polarization, and attains very low side lobe levels (more than 20 db down) to minimize multipath and RFI signal interference. TELTRAC Systems offer maximum installation flexibility—mobile, ground based or shipboard. For more information on TELTRAC including models for other frequency ranges and other tracking systems, contact Canoga for descriptive literature.



Engineers and Scientists: A number of key openings exist at Canoga in the fields of Radar, Telemetry, Trackers and Antenna Design and Development. Call or send resumé to J. McCann, Vice President.

canoga ELECTRONICS CORPORATION **15330 Oxnard Street, Van Nuys, California**





How the moon looks to Bellcomm

The moon is more than our nearest celestial neighbor. To Bellcomm it is a proving ground for work in the environment of space – meteoroids, radiation effects, magneto-hydrodynamic phenomena. It is a study in heat transfer, thermodynamics, combustion. It is a laboratory for application of the principles of solid state physics. It is a gigantic experiment in the life sciences, life support systems, and bio-engineering. It is electronics, propulsion, guidance, orbit mechanics . . . and more.

Bellcomm, a new Bell System company, offers experienced engineers, physical scientists, and technical men of many disciplines opportunities to engage in system studies involved in manned space flight programs for the National Aeronautics and Space Administration.

If you would like to be a part of Bellcomm, please send your résumé to Mr. W. W. Braunwarth, Personnel Director, Room 502F, 1737 L St., N. W., Washington 6, D. C. It will receive prompt, careful study. Bellcomm is an equal opportunity employer.

BELLCOMM, INC.
A Bell Telephone System Company

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 3 January 21, 1963

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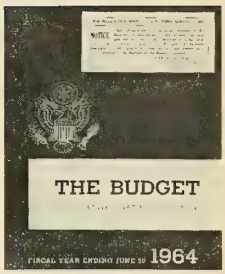
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THE COVER

Under this imposing cover, President Kennedy's Fiscal Year 1964 Budget was sent to Congress last week. Administration request for missiles and space hit a record $18.62 billion dollars. M/R's detailed, illustrated report begins on p. 12.



JANUARY 21 HEADLINES

FY '64 MISSILE/SPACE BUDGET REPORT—
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45,582 copies this week

†U.S. Reg. Pdg.

Circumlunar Vostok Flights

To the Editor:

The *Vostok III* and *IV* flights indicate that these types of vehicles could possibly be utilized for circumlunar flight. In past space operations, the Soviets have utilized simple but reliable equipment requiring minimal testing to reduce overall costs. Applying this philosophy to the *Vostok* flights, the Soviets can now perform sequential launchings and possibly achieve rendezvous (even though not actually demonstrated). By combining three vehicles of *Vostok*-class weight, circumlunar flight is possible.

The overall operation would require four launchings on successive days. These include placing in rendezvous orbit the following vehicles.

1. An unmanned propulsion module.
2. A manned rendezvous-control vehicle.
3. A manned propulsion module.
4. A manned circumlunar vehicle.

The first manned vehicle would control all rendezvous and docking operations. It would possess an airlock for manual docking control, and a heat shield for atmospheric entry at satellite speed. The second manned vehicle would have provision for trajectory correction and parabolic atmospheric entry.

The required differences in the two manned vehicles could have been tested in the *Vostok* operations, as indicated by conflicting reports. The first report from Russia stated that the pilots crawled from their capsules after they landed "according to plan," whereas a second report by the cosmonauts indicated they used parachutes.

The assembled circumlunar vehicle would possess two stages with the following specifications:

Weight Breakdown	
Total Weight	32,500 lbs.*
First-stage propellant	10,500
After staging	21,500
Second-stage propellant	9500
Command unit (excluding inert propulsion)	10,500
Performance	
Effective mass ratio (total vehicle)	2.697
Characteristic velocity (I_{sp} = 320 sec.)	10,220**

The sequential launching of several vehicles poses a tremendous logistics problem. As many as seven launch pads (including backup equipment) could be tied up with vehicles in approaching states of readiness at the same time. Whether the Soviets are capable of or willing to perform such a feat is a matter for speculation. The national acclaim, experience and lunar information to be gained from such an operation does, however, provide great incentive.

**Weights based on Soviet-announced Vostok useful weight of 11,400 lbs., less allowance for rendezvous. They may be larger, according to some estimates.*

***Performance capabilities of Soviet vehicles indicate that vacuum specific impulse of their exospheric engines could exceed 320 sec. The 10,000+ fps figure is adequate for the mission.*

Gerald A. Ouellette
Project Engineer-Space Research
Wolf Research and Development Corp.
West Concord, Mass.

Lady Engineers

To the Editor:

Your article on the impending shortage of engineering manpower (M/R, Jan. 7, p. 21) notes that "women remain an untapped source of talent." Have you considered the possibility that women are more rejected than untapped in the realms of technical endeavor?

I speak from experience. After some 3½ years on the West Coast as an electrical-electronics systems writer (Douglas *Thor* and Astronautics *Atlas*) I set about finding similar work at Cape Canaveral. A year and a half later, I am still looking.

The reaction among prospective "equal opportunity" employers varies somewhat, but generally speaking they act as though I were proposing to open a bawdy house on the premises or traffic in narcotics.

One supervisor was candid enough to admit that I was better qualified than most of his male applicants but he was afraid the "temperamental, prima-donna engineers" would not accept me. Working with engineers on the West Coast was no problem; being married to one for 11 years has not been a problem either.

Is the Cape too deep in the Deep South? What *are* these people afraid of?

B. R. Vogel
Cocoa Beach, Fla.

Meaning of 'Life'

To the Editor:

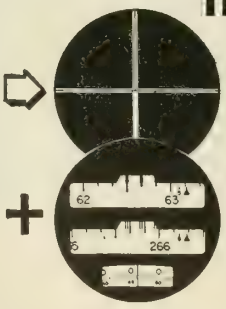
Your article on *Mariner* ("Mariner Triggers Intensive Activity," by Hal Taylor, M/R, Dec. 24, p. 16) was very good. One serious error cropped up, however. This seems common to much thinking these days, so I wish to put a stop to it.

In discussing the data in the second column, the end of the top paragraph has this sentence: "If this is confirmed by *Mariner*, no life is possible." Please correct yourself and say what you really mean—"no life as we know it." Of course we must limit the meaning of our statements these days with many modifiers, and this is an important area.

There will be conditions in which our type of human or plant life cannot exist, but we cannot say that all "life" is of this type.

Maitland McLarin
Huntsville, Ala.

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with
KERN DKM2 and DKM3
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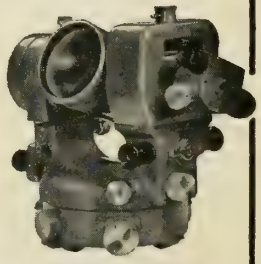


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POINTING ACCURACY

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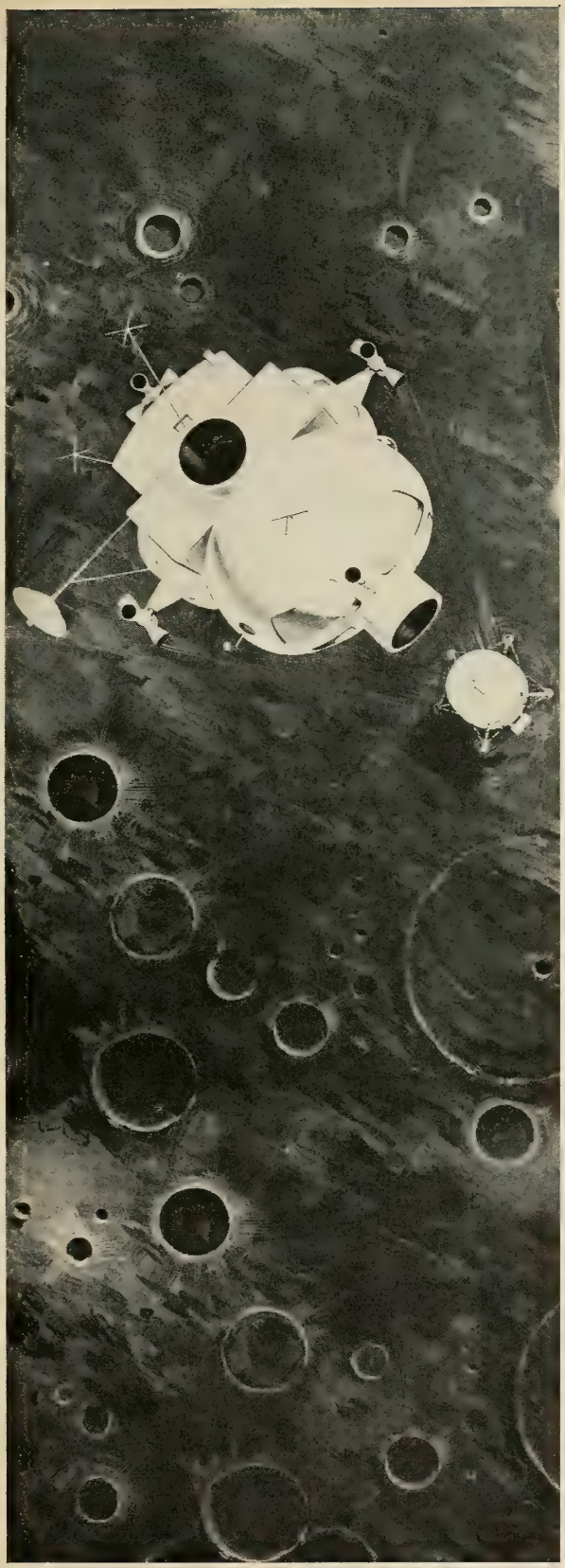
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LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

The selection of Grumman to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon, opens a new chapter in the conquest of space. Boosted by a three-stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface.

Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all times. Current requirements are detailed on the next page. We invite your inquiry on the attached inquiry form or by personal resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR-86.

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ENGINEERS & SCIENTISTS

Explore these immediately available positions:

Structural Designers — BS in CE, ME or AE with experience in light weight space vehicle design. Familiarity with materials in space environment and pressure vessel design essential.

Cryogenic Heat Transfer — Engineers and physicists with BS or MS and 3 years background in cryogenic tankage heat transfer to perform detailed analysis of configurations for main propulsion system and for other smaller low temperature containers. Will initiate experimental programs as necessary to verify analysis.

Temperature Control Engineers — BS or MS and 2 years experience to handle space vehicle temperature control system analysis. Should have background in radiative heat exchange and thermal coatings as applied to passive and active temperature control systems.

Electronic Cooling Engineers — BS or MS and 2 years experience to perform challenging work on both high density air and liquid cooled electronic equipment, and electronic equipment which must operate in a vacuum. Must be able to perform detailed analyses of equipment cooling requirements and initiate necessary thermal tests.

Internal Aerodynamicists — BS or MS in AE, ME with minimum of 3 years experience in Fluid Dynamics work applicable to liquid rocket propulsion systems, nozzle flow analyses, pressurization system design, throttling performance; injector and thrust chamber propellant flow analyses.

Gas Dynamicists — BSME or MS with minimum of 3 years experience and capability to perform analyses and tests of reaction jet control systems, jet exhausts, and gas lubricated bearings.

Reaction Control Engineers — BS degree plus a firm background in small liquid rocket engines, analysis, and testing. Will be responsible for the development of liquid rocket attitude control system for manned space vehicle.

Test Analysis Engineers — BS degree plus 3 to 5 years direct rocket test experience, to work on manned space propulsion liquid rocket engines and propellent systems. Must have ability to plan test programs and analyze test results to evaluate overall performance characteristics.

Rocket Propulsion Engineers — Engineers with 2-5 years of direct experience in the analysis, design, development, and testing of liquid rockets. An advanced degree and additional experience in propellant analysis, IBM programming, and proven ability in the field of liquid rocket engines is required. Work involves development of manned liquid rocket propulsion systems. Supervision capability is very desirable. Both junior and senior positions available.

Programming Specialists — B.S. or M.S. in engineering, physics or mathematics with 4 years experience in Electronic Data Processing. To generate original programs and analyze coding of existing programs. Knowledge of IBM, 7090 and 1620 machine coding is considered essential. Programs involve matrix algebra operations, time dependent solutions and integrations. Experience in analog-digital programming would be useful but not essential.

Acoustics & Environmental Vibration—B.S. or M.S. in M.E. or A.E. with a minimum of 3 years experience in environmental vibration analysis of Aerospace structures and equipment. Vibration or acoustical testing experience is desirable. Opportunity to work on environmental vibration design problems in spacecraft.

Vibration Test Engineers — B.S. or M.S. in A.E. or M.E. with 2-5 years experience in vibration testing. Will plan and conduct vibration tests on spacecraft; analyze and interpret data, write reports; perform vibration analyses required in support of test. A working knowledge of current instrumentation, measuring and recording devices and techniques is required. Opportunity to perform original work, assume responsibility and travel to perform tests in outside facilities.

Space Dynamicists—B.S. or M.S. in Physics, Applied Math. or Applied Mechanics, with a minimum of 5 years experience in the analysis of flight dynamics with at least 2 years experience in space dynamics, e.g. disturbance torques, orbital mechanics, lunar trajectory analysis, and separation system dynamics.

Guidance Dynamicists — B.S. or M.S. in A.E., E.E., M.E. or Applied Mechanics with a minimum of 2 years experience in the analysis of guidance systems for spacecraft. To analyze and evaluate functional configurations and dynamic characteristics of radar, IR, optical and inertial guidance loops; signal processing and error analysis. Background in sample-data and non-linear controls systems analysis techniques is desirable.

Control Dynamicists — B.S. or M.S. in A.E., E.E. or M.E. with a minimum of 2 years experience in analysis of control systems for spacecraft. Will evaluate automatic flight control system stability and performance. Familiarity with non-linear techniques, digital control techniques and adaptive control techniques is desirable.

Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all time. Mail the attached inquiry form to Mr. W. Brown, Manager, Engineering Employment, Dept. GR-86.

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PROFESSIONAL PLACEMENT INQUIRY

For your convenience and to facilitate your inquiry, please use this form. It will enable the professional staff at Grumman Aircraft to evaluate your background and experience and arrange for a mutually convenient personal interview. All inquiries will be held in strictest confidence. Enclose in an envelope and send to Mr. W. Brown, Manager, Engineering Employment, Dept. GR-86, Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

NAME_____

STREET ADDRESS_____

CITY & STATE_____ TELEPHONE_____

NEAREST MAJOR CITY (IF APPLICABLE)_____

COLLEGE GRADUATE: YES___ NO___ Degree Subject Year

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Major Speciality_____ Yrs.____ Other Speciality_____ Yrs.____

Applying for position(in)(of)_____

Background and experience (Brief resume of experience, recent history of employment)

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Circle No. 7 on Subscriber Service Card

The Countdown

WASHINGTON

Nike-Zeus Future Is Much Brighter

Radical improvements embodied in the new *Nike-X* antimissile missile have brought a full reconsideration of the AICBM program at Dept. of Defense levels. Secretary McNamara felt the changes were so significant he even considered an entirely new name for the weapon. To avoid confusion, however, it will be designated part of the *Nike-Zeus* system. Development of the high-Mach *Sprint* missile also will be instituted as a complement to the *Zeus* system.

Redeye Missile Remains in R&D Stage

Continuing development problems of the General Dynamics/Pomona *Redeye,* bazooka-type surface-to-air missile, mean it will continue in the R&D stage. No procurement funds are provided in the Fiscal '64 budget request.

Russian Launch Data Hard To Come By

NASA has quietly dropped its practice of releasing information on Soviet manned spaceflight and satellite launches. The reason—a double rebellion against (1) Administration policy which prohibits disclosure of Soviet space failures and (2) the space agency's inability to get information from Air Force tracking facilities. NASA officials say that as far as Soviet launchings are concerned, "all we know is what we read in the papers."

Premature Plans for Mars

Some Goddard Space Flight Center scientists were quietly squelched by NASA headquarters when they proposed to present a paper on a Mars landing capsule at the American Astronomical Society meeting in Los Angeles. Headquarters said no for two reasons—one, Congress hasn't approved the program and no funds are available; two, no decision has been made to give Goddard an assignment to develop such a capsule.

Pentagon in Charge of Low-Orbit ComSat

Defense Dept. has now been given primary responsibility for developing a low-altitude communications satellite. NASA will concentrate on high-altitude synchronous satellites such as *Advanced Syncom.*

NASA Bolstering Staff

The space agency has embarked on an urgent three-month drive to recruit scientists and engineers. They're needed by all NASA centers, especially the Lewis Research Center, hard-pressed because of its new responsibilities for *Centaur* and the M-1 engine. Recruiters will visit 101 cities.

INDUSTRY

Apollo Engine Progresses

Aerojet-General has successfully fired the Service Module engine that will power midcourse maneuvers of *Apollo.* North American engineers have determined how much propellant the engine will need for the return to Earth, but are not releasing the figure for fear of revealing the level of U.S. military technology. Tankage for the system is being designed with a 25% margin over calculated requirement—this on assumption that *Advanced Saturn* booster performance can be made better than presently estimated, and that the weight of the Command and Excursion modules can be cut.

MOSS Power System Bids Sought

NASA's Manned Spacecraft Center at Houston has asked industry for proposals on a power system for a manned orbiting space station. Contractor will investigate and compare electrical power systems, power generation, energy storage and power distribution. Deadline for submission of bids is Feb. 5.

Space Communications Corp. Eyes Charyk

Recent rumors that Under Secretary of the Air Force Joseph V. Charyk may be leaving his post were given new credence last week when it was reported that he was being considered for a top management post in the new Space Communications Corp. The body, created last summer, will build and operate a world-wide commercial communication satellite system. Charyk, 42, has been in his present post since January, 1960, and is considered the AF's top authority on technical research. Reliable sources said no decisions had been made as to Charyk's role in the corporation, and he couldn't be reached for comment.

INTERNATIONAL

French Plan New Range

France will build a civilian range 15 miles north of Perpignan on its Mediterranean coastline for launching the first all-French satellite in 1965. The shot will utilize a *Diamant* vehicle to be tested at a military range, also yet to be constructed, at Biscarosse. The civilian range, near the town of Leucate, was chosen partly because it will permit launching toward the east. Both new ranges will be ready in time to replace France's launch sites in Africa, which must be evacuated in the next three years.

British Cautious on Stopgap

There are indications in London that Treasury officials may veto any decision to go ahead with a purely British deterrent weapon as a stop-gap until Britain receives *Polaris.* The latest proposal is that Vulcan bombers be adapted to enable them to fly below the Soviet radar screen, so that *Blue Steel* can still be used. A report from Australia recently suggested that *Blue Steel* had performed with great accuracy at ranges well over 200 miles —but this was discounted by officials in London as "entirely speculative."

Finns Place Latest Vigilant Order

The Finnish defense forces have ordered an undisclosed quantity of *Vigilant* antitank rockets from the British Aircraft Corp. They're to be delivered this year. The Finnish order came shortly after India's Prime Minister Nehru asked Britain to provide 40-50 *Vigilants* in the wake of the Red Chinese aggression (COUNTDOWN, Jan. 7, p. 11).

Apollo Flight Checks Set

Initial flight qualification of *Apollo* hardware will begin at White Sands Missile Range next summer, according to Charles W. Frick, head of the *Apollo* project at the NASA Manned Spacecraft Center.

Frick was speaking during the first familiarization conference between North American Aviation, prime contractor for *Apollo,* and Grumman Aircraft Engineering Corp., Lunar Excursion Module contractor.

Frick was also participating in negotiations of the final *Apollo* contract between NASA and North American. The contract was awarded in December, 1961, but is only now being finalized. In the interim, the company has increased its *Apollo* staff from 100 to about 8000.

The contract will be about three times as large as any other government contract in history. A wide disparity in government and North American cost estimates for the program is indicated by Frick's refusal to peg the bargaining range any more precisely than "between $500 million and $1 billion."

John W. Paup, *Apollo* manager for North American, admitted to MISSILES AND ROCKETS that the company is asking very close to the upper figure. North American is now spending *Apollo* money at a rate of about $12 million per month. Half the value of the final effort will be subcontracted.

Frick said the difficult management interface problems have been solved. The $350-million Grumman LEM contract was negotiated in what he calls record time. Frick said *Apollo* funding is pretty tight. He said he does not believe program cost estimates have risen since last June, but he professed ignorance about the trend before then. He has only held his present job since February, 1962.

Britain Plans Polaris Subs

At least four *Polaris*-launching submarines are planned by Great Britain, with costs estimated at $700 million. The figure includes the construction cost of the submarines and the missiles (without warheads), but not the long-range maintenance of the fleet.

Thus, while costs between *Skybolt* and *Polaris* deterrents seem fairly similar initially, the long run will see *Polaris* costing considerably more. To fill the gap between *Blue Steel* and *Polaris,* Britain is planning an advanced *Blue Steel* version and may use its TSR-2 aircraft and the new *Pandora* missile now under development.

The Royal Navy estimates it will have the first *Polaris* submarine ready by 1967-68, but the Defense Ministry is more conservative. Even at the earlier date, however, there will be some sort of gap to fill, since *Blue Steel* as presently used will phase out by about 1967.

Shots of the Week

• The Navy successfully launched its Martin *Bullpup B* missile from an A4D Skyhawk jet near China Lake, Calif. It impacted in a preset desert target area.

The launch was the first in the air-to-surface missile's technical evaluation program. This follows the contractor's development and demonstration flight test phase. The extensive test series is designed to ready the conventional-warhead-carrying *Bullpup B* for operational status.

• A *Thor-Agena* booster carried aloft another secret Air Force satellite from Vandenberg AFB Jan. 16. This is the same booster combination used in earlier announced *Discoverer* series firings.

• A Martin *Titan II* launched Jan. 10 from Cape Canaveral fell far short of its intended 6300-mi. range after developing second-stage troubles.

The Air Force said many of the flight's objectives were achieved, but the missile reportedly missed its target area by "hundreds of miles."

Merritt Island Bids To Open

The Army Corps of Engineers will open bids Feb. 14 on $5.5 million in utilities to service the 40 buildings planned on Merritt Island near Cape Canaveral for the manned lunar landing program.

The project will include installation of streets, water distribution systems, sewage system, electrical distribution system and a central heating plant.

The utilities are expected to serve a population of 8000 employees who will be working there by 1967.

NASA Slates Industry Confab

The National Aeronautics and Space Administration will hold its second Industry Program Plans Conference Feb. 11 and 12 at the Departmental Auditorium, Washington, D.C.

Purpose of the meeting is to outline NASA plans to private industry, which receives some 90% of the agency's budget. The first of these meetings was held in July, 1960. Since that time, NASA organization changes and growth created a growing demand for a second such session.

The conference is particularly designed for current or potential contractor firms' personnel who direct long-range planning, research and engineering and who are concerned with their own in-house aerospace programs and project proposal formulation. More detailed follow-on conferences may be held later at selected NASA field centers involved with major procurement.

While the meeting is unclassified, registration will be required for admission. This is necessary to assure that all bona fide industry personnel desiring to attend can be accommodated with the 1500 seats available.

Those desiring to attend are urged to complete their registration as early as possible. Forms may be picked up beginning Feb. 4 in Room 50058, NASA Headquarters, Federal Office Building 6, 400 Maryland Ave., Washington. Registration forms are not to be requested by mail, but late arrivals may register Feb. 11 at the meeting.

HX-1 'Copters Delayed

The Air Force disclosed FY '63 plans to buy 25 HX-1 missile-site-support helicopters, once specifications for the craft have been met.

Competing for the helicopter contract are Kaman Aircraft Corp., Bell Helicopter Co. and Sikorsky Aircraft Div. of United Aircraft Corp.

A decision on the contract has been deferred until late April because none of the firms' off-the-shelf proposals meet the craft's specified operational requirements. The Air Force has asked for new proposals.

Planned procurement for FY '64 has been set at 30, and purchases may continue for three fiscal periods.

Space Signals Unexplained

A Swedish government tracking station last week received signals that might emanate from a new satellite. Spokesmen at the Enkoeping station said characteristics of the signals indicated the space object had a period of about 95 min.

The station said the signals did not come on a frequency used by Soviet *Vostok* space ships for voice communications, nor did they correspond with those used in Russia's *Cosmos* satellite series.

Industry-Labor Developments

The Boeing-IAM dispute remained unsettled last week, though some progress reportedly was made. Representatives of labor and management agreed to postpone the strike deadline until last Friday at midnight, so that added talks could be held.

The 88th Congress is expected to consider legislation affecting the federal government behavior in labor disputes in missile/space and other critical industries.

Sen. Frank J. Lausche (D-Ohio) is drafting a bill that prohibits federal officials from "forcing their judgments of . . . right and wrong" upon either labor or management. Lausche says limits must be set by law on the extent to which agencies can go in "coercing" both parties in labor disputes.

NASA, India in Joint Program

An agreement reached last week by NASA and India's Department of Atomic Energy will result in launching of 13 rockets in a cooperative research program to study the equatorial electrojet current and upper atmosphere winds.

—Cislunar Chart Reprints—

Reprints of the chart, "Properties of Cislunar Space," which appears on pages 26-27 of this issue (center spread) are now available from:

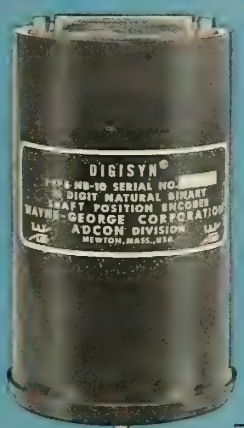
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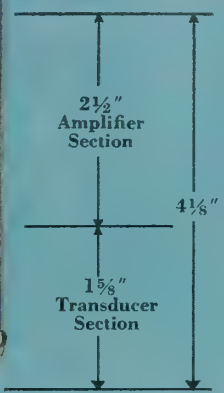
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Record $18.62 Billion Asked

NASA's $5.7-billion request accounts for nearly all of increase; missiles level off; little for military space

PRESIDENT KENNEDY has asked Congress to approve a budget which provides some $18.62 billion for missile and space programs in Fiscal 1964—almost one-fifth of the total budget request for the year.

The increase of $2.4 billion over the FY '63 missile/space budget comes almost entirely from the booming National Aeronautics and Space Administration lunar program. Military spending on missiles is leveling off with completion of funding for the *Atlas* and *Titan* ICBM's. Final procurement of the *Titan II* ICBM falls in the FY '64 budget.

Planned increase in spending on military space programs is negligible. The budget in this area climbs from $1.5 billion to $1.667 billion.

NASA's budget request totals more than $5.7 billion. The Dept. of Defense overall budget of $55.2 billion in total obligational authority (TOA) is up $2.4 billion from Fiscal 1963. This does not include the nearly $2 billion for nuclear warheads which must be added for a full picture of U.S. defense expenditures.

DOD has continued its emphasis on programming by combat missions rather than by service departments. The budget for *Polaris* submarines, for example, is considered as part of the strategic retaliatory force package under this philosophy rather than under the Navy's shipbuilding program. Six new *Polaris* submarines are requested, for a total of 41, carrying 656 missiles.

Procurement of 150 more *Minuteman* is planned, for a total force of 950.

• **Lost plateau**—It appears clear that DOD has abandoned the hopes of reaching a plateau in defense spending which it emphasized last year. But defense spending on military missiles and military astronautics does not increase significantly in the new budget. Some 50% of the FY '64 budget increase comes from stepped-up military pay levels.

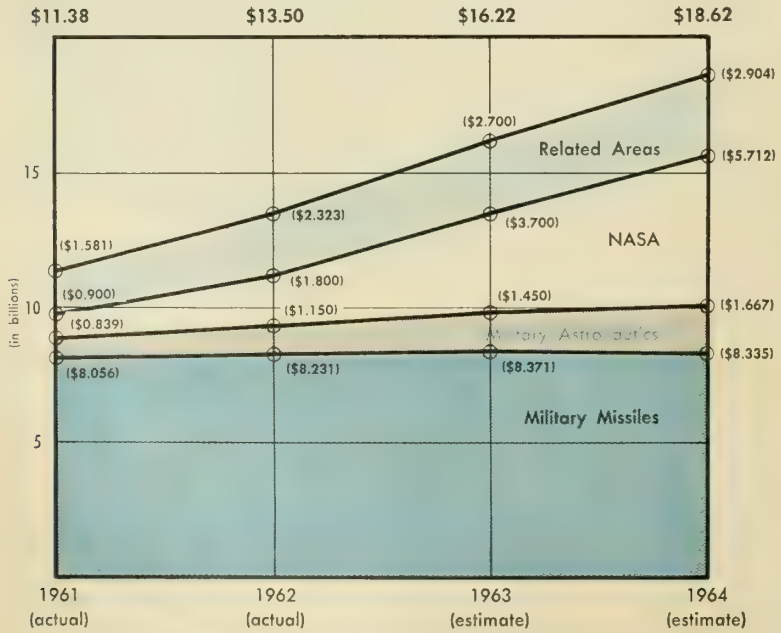
Spending on missile base construction, now to be largely for *Minuteman*, remains level. Electronics spending climbs somewhat. Funding of *Polaris* submarines declines slightly with the 41-ship goal in sight.

The Administration decision to hold spending on the *Apollo* lunar program to a level which will result in a six-month delay when compared to the fastest possible accomplishment of a lunar landing seems certain to run into criticism from Congress. The low level of funding of the military space program also is likely to be questioned.

These were other trends in the missile/space budget:

• NASA expenditures in FY '64 will rise to $4.2 billion, an increase of 75% over the current year's level of $1.8 billion. Spending thus continues to lag behind new money requests.

• Spending on military missiles now has remained at almost a constant level over a four-year period, with *Minuteman* and *Polaris* phasing in as *Atlas* and *Titan* procurement phases



How Missile/Space Spending Has Climbed

Missile/Space FY '64 Budget Request

(in millions of dollars)

Missile Procurement	*4,108.0*
Missile RDT&E	*2,227.0*
Missile Maintenance	*1,500.0*
Missile Base Construction	*650.0*
Polaris Submarines	*702.3*
NASA R&D	*4,881.0*
NASA Construction	*785.0*
Military Astronautics	*1,667.6*
AEC Astronautics	*254.3*
Weather Bureau Astronautics	*26.2*
NSF Astronautics	*2.3*
Associated Electronics	*450.0*
Other	*1,370.0*
TOTAL	*18,623.7*

out. The Air Force decline in missile procurement is more than matched by increased Army and Navy spending.

• Calendar 1964 will see the U.S. in possession of an awesome capability to survive a first strike and still totally destroy the Soviet target system. This force will include some 1100 land-based ICBM's, 500 air-launched *Hound Dog* missiles and nearly 500 *Polaris* missiles on station in addition to warheads carried by B-52 and B-58 aircraft.

• Significant improvements in the *Nike-Zeus* antimissile system are causing top Defense Dept. officials to take a whole new look at the program. The budget provides some $425 million in the AICBM field, although there will be no procurement of the *Zeus* system.

In terms of new obligational authority (NOA), the Administration estimates its FY '64 space budget at $7.614 billion, an increase of $2.1 billion over last year. This includes the NASA program, identifiable DOD programs, and programs at the Atomic Energy Commission, the Weather Bureau and the National Science Foundation.

It does not, however, include spending which cannot be easily separated from other programs, such as development of missiles used as space boosters. Overall budget in this category therefore is higher by about $2 billion.

The budget breaks down the identifiable funds as: NASA, $5.664 billion; DOD, $1.668 billion; AEC, $254.3 million; Weather Bureau, $26.2 million and National Science Foundation, $2.3 million.

NASA

A SIX-MONTH DELAY in the timetable for the first U.S. manned lunar landing is certain despite a whopping $5.7-billion NASA Fiscal '64 budget request.

Neither will the record budget prevent delay or cancellation of other space agency programs including *Rebound, Advanced Relay, Voyager, Aeros, Nova, Lunar Logistics Vehicle* and the *Manned Orbiting Space Station.*

It is also the first public declaration that NASA unmanned scientific exploration programs will be de-emphasized if Project *Apollo* costs require it.

The request for the next fiscal year is a $2-billion increase over the Fiscal '63 budget of $3.7 billion. It calls for total authorizations of $4.9 billion for research, development and operations (RD&O), and an $8-million construction program.

By far the biggest slice will go to NASA's manned spaceflight activities. Projects *Apollo* and *Gemini* call for funding of $3.2 billion for RD&O and new construction of $564 million. Other NASA programs including space sciences, advanced research and technology, space applications, and tracking will split the remaining $2 billion.

• **Alternatives rejected** — Despite the high level of funding, Administrator James E. Webb called it an "austerity" budget.

He said that the space agency had proposed two higher budgets—$6.2 and $6.6 billion—as alternatives. Webb declared, however, that the approved budget "will permit us to satisfactorily carry out a manned lunar landing before the end of this decade."

The $6.2-billion proposal, it was

(Continued on page 16)

NASA RESEARCH, DEVELOPMENT AND OPERATION
(in thousands of dollars)

	FY 62	FY 63	FY 64
MANNED SPACE FLIGHT	677,784	1,707,019	3,193,641
Spacecraft Development & Operations	193,192	766,696	1,647,441
Launch Vehicle Development	468,048	852,808	1,319,454
Aerospace Medicine	10,130	10,811	21,840
Integration and Checkout	1,745	41,834	157,378
Systems Engineering	4,669	34,870	47,528
SPACE APPLICATIONS	76,237	118,101	136,559
Meteorology	39,696	64,289	73,085
Communications	35,591	49,049	55,771
Advanced Application Satellites	73	1,003	1,604
Industrial Applications	877	3,760	6,099
UNMANNED INVESTIGATIONS IN SPACE	389,342	547,208	754,765
Spacecraft Development & Operations			
Geophysics and Astronomy	119,771	174,209	232,624
Lunar and Planetary Exploration	164,631	226,392	331,270
Bioscience	4,082	25,112	41,339
Launch Vehicles and Spacecraft	100,858	121,495	149,532
SPACE RESEARCH AND TECHNOLOGY	193,980	342,489	463,863
Launch Vehicles and Spacecraft			
Space Vehicle Systems	58,869	89,758	111,407
Electronic Systems	24,491	44,875	59,286
Human Factors Systems	4,996	14,075	24,387
Propulsion and Space Power			
Nuclear Electric Systems	38,194	61,098	89,605
Nuclear Rockets	38,010	89,248	118,919
Chemical Propulsion	17,164	25,119	35,075
Space Power	12,256	18,316	25,184
AIRCRAFT TECHNOLOGY	28,773	43,990	45,126
SUPPORTING OPERATIONS	97,379	191,447	318,046
Tracking and Data Acquisition	83,832	159,781	261,608
Facility, Training and Research Grants	13,547	31,666	56,438
TOTAL	1,463,495	2,950,254	4,912,000

NASA FACILITIES CONSTRUCTIONS PROGRAM
BY LOCATION
(in thousands of dollars)

LOCATION	FY 62	FY 63	FY 64
Ames Research Center	6,564	14,200	13,076
Flight Research Center	110	1,697	4,081
Goddard Space Flight Center	12,170	17,556	20,932
Jet Propulsion Laboratory	4,064	10,003	7,000
Langley Research Center	6,942	8,861	9,768
Launch Operations Center	116,291	326,974	312,855
Lewis Research Center	1,835	43,485	25,835
Manned Spacecraft Center	66,689	45,283	37,736
Marshall Space Flight Center	30,318	43,560	38,496
Michoud Plant	10,723	18,294	10,003
Mississippi Test Facility	18,990	73,200	111,690
Nuclear Rocket Development Station	22,930	17,470	20,490
Pacific Launch Operations Office	975	—	—
Various Locations *1	47,874	99,721	176,038
Wallops Station	11,714	4,161	2,000
Facility Planning and Design *2	1	4,864	10,000
Reserved for allocation under reprogramming authority	—	8,096	—
TOTAL	358,190	737,425	800,000

*1 Excludes amounts appropriated for facilities at various locations in Fiscal Years 1962 and 1963 which are now identified as part of specific NASA installations.

*2 Amounts appropriated in Fiscal Years 1962 and 1963 are reflected by location on the basis of current allocations.

FY '64 Budget—

DEFENSE

ATLAS	Training missiles and equipment procurement continued, as well as retrofit and spares.
TITAN I	Training missiles and equipment procurement continued, as well as retrofit and spares.
TITAN II	Procurement to be completed.
TITAN III	Development continued as space booster workhorse.
MINUTEMAN	Production, installation and checkout continued, as well as retrofit and spares. Advanced version development continued. Additional buy of 150 for total of 950.
POLARIS	Procurement continued, and high priority assigned to improved version development. Support facilities to be built for both Atlantic and Pacific fleets. Missiles operational in 1966: 496.
SKYBOLT	Cancelled.
DYNA-SOAR (X-20)	Development continued.
ASROC	Procurement continued.
BMEWS	Support continued; reduction over FY '63 funding due to near-completion.
BULLPUP	Procurement increased for USN; procurement continued for USAF in both operational and trainer versions.
DAVY CROCKETT	Procurement continued.
DEFENDER	Support continued.
FALCON	Procurement continued.
FIREBEE	Procurement continued.
HAWK	Procurement continued.
HONEST JOHN	Procurement continued on improved versions.
HOUND DOG	More than 500 operational in 1966.
LANCE	Development continued.
LITTLE JOHN	Procurement continued on improved versions.
MAULER	Initial procurement and continued development.
MMRBM	Development planned if program definition phase satisfactory. DOD does not regard Polaris as alternative to either land- or sea-based versions.
NIKE-HERCULES	Procurement continued; sites to be improved and modified for fallout protection.
NIKE-ZEUS	Major R&D effort of $325 million, as well as initial development of a more advanced ballistic missile defense system. Extensive research on other techniques to be carried out by ARPA.
NIKE-X	Initial development to be undertaken at a high level of effort. Part of Zeus system.
PERSHING	Procurement continued.
REDEYE	Continuing R&D. No procurement due to development problems.
SAINT	Development continued on improved techniques.
SERGEANT	Procurement continued.
SHRIKE	Procurement increased for USN; procurement initiated for USAF.
SIDEWINDER	Procurement continued.
SPADATS	Support continued, facilities construction to continue.
SPARROW	Procurement continued for USN; procurement initiated for USAF.
SPRINT	Funded as complementary system to Nike-Zeus, Nike-X.
SUBROC	Procurement accelerated, development continued.
TALOS	Procurement continued in phase with related ship program.
TARTAR	Procurement continued in phase with related ship program.
TERRIER	Procurement continued in phase with related ship program.
TRANSIT	Development continued.
TYPHON	Development continued.
WALLEYE	Procurement to be initiated.

AEC

ROVER	Reactor development for NASA nuclear rocket program rises from $71 million to $98.9 million.
SNAP	Funding for reactor research for NASA program continues to rise, hitting $85.9 million.
PLUTO	R&D funding for DOD's nuclear-powered missile system cut back sharply from $22 million in FY '63 to only $9 million.

Programs at a Glance

NASA

MERCURY	Last flight scheduled for April, 1963. No funds requested in FY 1964.
APOLLO	Funding to nearly triple—$1.2 billion tagged for Command, Service & Lunar Excursion modules.
GEMINI	Total requested authorization is $306.3 million, compared with $232.8 in the current year. First manned orbital flight will be attempted in 1964.
LUNAR LOGISTICS VEHICLE	No development funds requested.
MANNED ORBITING SPACE STATION	No hardware money included in budget request. Some funding of study contracts likely.
ADVANCED SATURN	Budget for 7.5-million-lb.-thrust booster up almost 200%—to $733 million.
SATURN	With first two-stage flight scheduled for mid-1963, development will drop to $131.6 million.
SATURN B	With development of improved one-J-2-engine stage just beginning, budget will jump from current $18 million to $68.6 million in FY '64.
LIQUID ROCKET ENGINES	Funding rising only slightly—$48.2 million for J-2, $54.1 million for F-1 and $45 million for M-1.
NOVA	No specific budget request, but part of $80-million launch vehicle R&D budget could be used for further study of giant booster.
TIROS	Funding slashed by two-thirds, to $7.2 million.
NIMBUS	Will get primary emphasis in weather satellite area, with funding of $43.8 million.
AEROS	No specific funding requested.
ECHO	Sharp drop-off—to only $200,000—as passive ComSat program is ended.
RELAY	Funding slashed to $1.9 million as DOD takes over responsibility for low-altitude system.
ADVANCED RELAY	No funds requested. Project apparently killed.
REBOUND	No funds requested. May continue as R&D project.
SYNCOM	Budget drops to $4 million as emphasis moves to advanced system.
ADVANCED SYNCOM	NASA now has prime responsibility for development of high-altitude ComSat. Budget jumps to $40 million.
ADVANCED APPLICATIONS SATELLITES	Only $1 million requested, perhaps for study of navigational and data-gathering satellite systems.
INDUSTRIAL APPLICATIONS	Budget calls for only $3.5-million program to make NASA technology available to industry.
SCIENTIFIC OBSERVATORIES	Funding to $132 million requested for OGO, OSO and OAO.
SCIENTIFIC SATELLITES	Budget rises slightly—to $26.8 million—for Earth satellites.
INTERNATIONAL PROGRAMS	Cut back from $12 million to $7 million.
RANGER	Lunar hard-landing spacecraft budget increases slightly, to $90 million.
SURVEYOR LANDER	Funding set at $69.3 million in effort to meet 1965 launch date.
SURVEYOR ORBITER	Gets first major funding support, with 14-fold increase to $28.2 million.
MARINER	Budget almost doubles, to $100.1 million for 1964-65 interplanetary missions.
VOYAGER	No R&D funds requested. Some study contracts may be awarded.
PIONEER	New solar probe program kicked off with $15-million request.
BIOS	Flight program to orbit squirrel monkeys and other life forms rises sharply—from $10.9 million in current fiscal year to $24.2 million.
SCOUT	R&D completed. Procurement funds included in other programs.
DELTA	R&D completed. Procurement funds included in other programs.
CENTAUR	High-priority upper-stage program funding rises slightly, to $110.7 million.
RE-ENTRY PROJECTS	Funding remains level—at $14 million—for Project Fire and other programs.
MICROMETEOROID SATELLITES	New 4000-lb. satellite program earmarked for $5.2 million.
SNAP-8	Funding rises from $15.9 million in FY '63 to $24 million.
SERT	R&D program increases by 300%, to $15.3 million.
NERVA	Nuclear rocket engine program budget continues to rise, to $60 million.
RIFT	Funding for nuclear rocket stage stays at low ebb with $12-million request.

WEATHER BUREAU

METEOROLOGICAL SATELLITES	Procurement and launch of Nimbus satellite budgeted at $23 million. Another $20.6 million in unobligated FY '63 funds also available.

(Continued from page 13)

learned, permitted a manned lunar-landing attempt as early as late 1967.

A NASA official admitted that the approved budget will mean a delay of about six months, putting the earliest date for the mission back to 1968.

D. Brainerd Holmes, director of space agency manned space missions, told MISSILES AND ROCKETS that the "budget provides every hardcore item we requested." He added that he would have liked to have had funds approved for the development of *Lunar Logistics Vehicle* and the manned station.

The high priority of manned space programs within the space agency was emphasized by Administrator Webb.

He pointed out that President Kennedy had declared in his budget message that Project *Apollo* has the highest priority in terms of NASA's budget.

NASA's unmanned scientific programs, the President told Congress, have only the same priority accorded to other Federal research programs.

This appeared to be an open invitation to Congress that if cuts in the budget are to be made, the axe should fall in the unmanned areas having little effect on *Apollo*.

Other major program changes and policy switches revealed by the budget include:

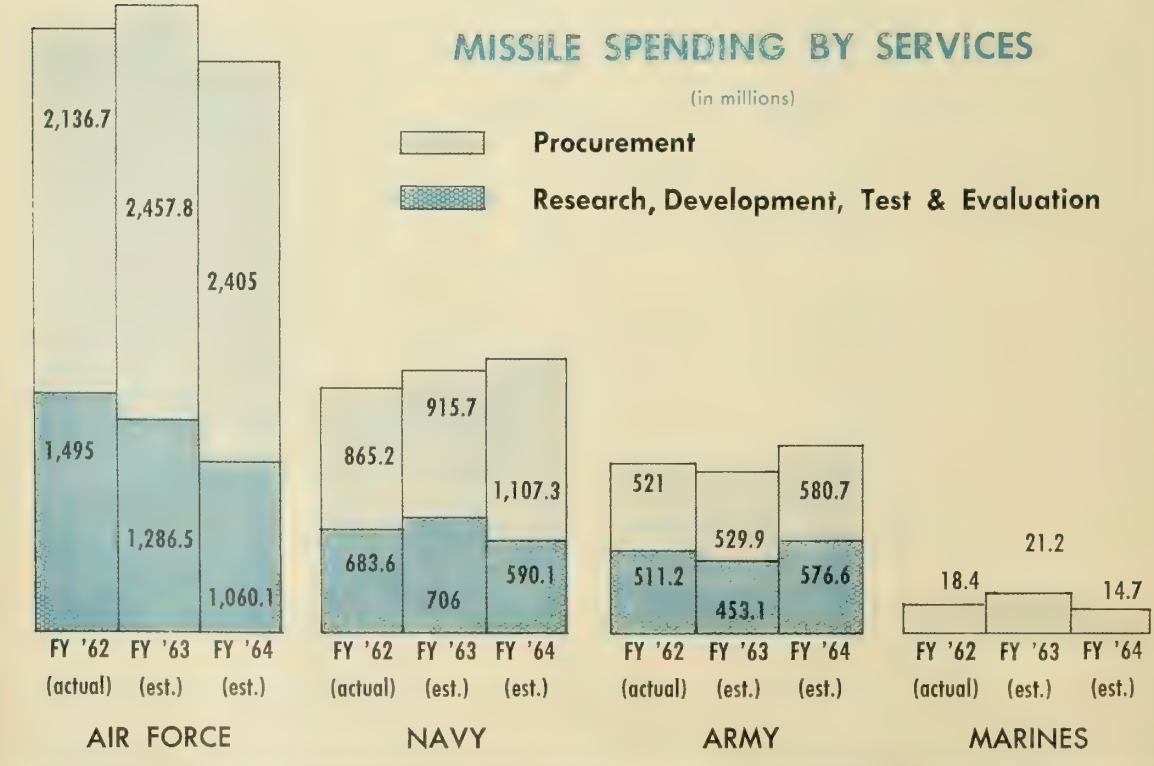
• *Boston center*—NASA will ask Congress for authority to build a new Electronics Research Center in the greater Boston, Mass., area. The Fiscal '64 request of $5 million will cover only $3 million in land acquisition costs and $2 million for facility planning.

• *Manned Space Flight*—No development money was requested for the *Nova* superbooster, *Lunar Logistics Vehicle (LLV)*, and *Manned Orbiting Space Station*. Funding for all three appears to be delayed for at least another year. The *Apollo* spacecraft program budget request totals $1.2 billion, with about $650 million for the Command and Service modules, over $200 million for the *Lunar Excursion Module (LEM)*, $150 million for guidance and navigation systems, and the remainder for procurement of *Saturn* and *Little Joe* launch vehicles. No funds were requested for Project *Mercury* because it will end if the April launch is successful. Funding for Project *Gemini* is set at $306 million.

• *Unmanned Investigations in Space*—Planning now calls for a total of 24 *Ranger* lunar hard-landing spacecraft. Funding through Fiscal '64 provides for 14, with 10 more flights still under consideration. A $26.8-million budget request for small scientific satellites includes funds to pay for NASA assumption of the *ANNA* geodetic satellite program. Two other new programs will also be funded. One, a *Pioneer* solar probe, is earmarked for $15 million. The second is a planned series of space flight missions to orbit various life forms for long periods. A $24.4-million authorization has been requested.

Although funds for a *Surveyor* orbiter are included in the budget, a final decision on the project still has not been made. The *Mariner* spacecraft funding request of $100 million will cover *Mariner* flights in 1964 as well as the heavier *Mariner B* spacecraft which will be used in 1965.

• *Space Applications*—NASA now has primary responsibility for development of high-altitude communication satellites. This will boost the funding requests for the *Advanced Syncom* project to $40 million. DOD has responsibility for development of an operational system at lower altitudes. As a result, funding for *Relay* has dropped sharply and no funds have been requested for



the previously planned *Advanced Relay* satellite and Project *Rebound*.

In the weather satellite area, NASA will request $43.8 million to develop four *Nimbus* satellites. NASA also plans three more *Tiros* flights and the Weather Bureau is funding an additional four satellites, using Fiscal '63 funds. No funds were requested for the *Advanced Aeros* meteorological satelilte.

In the Advanced Application Satellite area, the space agency is requesting $1 million to study possible navigation and data-gathering spacecraft.

• *Space Research and Technology*—Only $12 million is being requested for the *RIFT* nuclear rocket stage. This will cover only subsystem technology and preliminary funds. If reactor problems are licked, Webb said that it is likely the Administration will approve a supplemental appropriation for the program.

The $14-million budget for re-entry projects will cover Project *Fire* as well as a planned program in which re-entry speeds of 4500 ft. per second will be attained.

• *Construction*—Major item in the $800-million construction budget is $217 million incremental funding for launch complex 39 at Cape Canaveral New tracking facilities will cost $176 million, including three new tracking ships and three stations located in Australia, California and an undetermined site in Africa.

Dept. of Defense

A GENERALLY CONSERVATIVE trend in missile/space spending is visible throughout the Dept. of Defense budget, with missiles holding at about the same level, and military astronautics increasing very slightly. The $2.4-billion increase in the overall defense budget, said Secretary McNamara, is more than half due to increased compensation for members of the armed forces.

The budget requests submitted to McNamara by the services were about $13 billion more than the budget he finally approved for forwarding to the President. Consisting of 629 separate items, the requests were cut for about 400 items, of which 73 were appealed by the services. McNamara subsequently improved funding for about 25 of these.

"I would estimate that 75% of the items we cut from the military budget requests had nothing to do with maintaining force levels," he said, adding that many of the slashed requests consisted of things like administrative aircraft. However, two major items in the killed portion of the budget requests were *Skybolt* and the RS-70.



1961 and '62 figures are actual; '63 and '64 are estimated.

Emphasizing that manned aircraft would be a key factor in our strategic retaliatory forces throughout this decade, McNamara said that by the end of calendar year 1966, the U.S. would have 700 B-52 and B-58 bombers, over 500 *Hound Dog* missiles, 1100 ICBM's, and 496 *Polaris* missiles operational, not including tactical nuclear weapons and aircraft-carrier-based weapons in inventory. The manned bomber force will thus drop from the figure of "more than 1000" which President Kennedy said the country would have in service at the end of 1964.

Budget Terms Explained

WHAT the Administration terms its Direct Budget Plan corresponds to Total Obligational Authority (TOA). This is the total cost of a program planned in connection with the particular fiscal year. This sum comes for the most part from Congressional authority to commit funds in that year and, in small part, from obligational authority granted in previous years but under which funds were not committed.

New Obligational Authority (NOA) is the amount asked from Congress after financial adjustment to allow for funds already authorized in previous years but not yet expended.

Obligated Funds represent contracts to be let in a given year, although the money itself may be disbursed in later years. Money actually to be spent in a given fiscal year is listed as Expenditures. This consists of funds obligated in that year or in earlier years for that year.

Most NASA figures emphasize NOA, while DOD is inclined to stress TOA.

• **Elusive $8 billion**—Despite the levelled-off missile/space spending, it has been pointed out that the Pentagon is spending a total of $24 billion more in a three-year period than did the Eisenhower Administration—an average of $8 billion more per year. However, this increase is not reflected in the current budget for missiles or space programs.

Funds from the cancelled *Skybolt* program will be applied to other programs, as yet unspecified, and DOD is now trying to determine the amount involved.

The large solid rocket program, although exact funding levels were not revealed, seems to be at a very slow pace, with the schedule calling for firing of first subscale motor in late '64.

The military communications satellite system, intended to operate at lower altitudes than the NASA synchronous communication satellite system, will be funded at about $100 million, and its management responsibilities shifted.

In overall procurement, as well as research, development, test and evaluation (RDT&E) of military missiles, DOD will spend $6.335 billion in FY '64, compared with $6.371 in FY '63, $6.231 in FY '62 and $6.056 in FY '61. Base construction costs for missiles and *Polaris* submarine costs have amounted to some $2 billion for each year.

Military space activity was funded at approximately $1.5 billion in FY '63, and has risen to only $1.667 billion in the current budget. ⌗

Prepping for Surveyor . . .

NASA Wins DX Priority for Centaur

Speedup program results from high-level space agency investigation after unsuccessful first launch last May

by Hal Taylor

NASA HAS OBTAINED DX priority—the nation's highest—for the *Centaur* program in a drive to get the liquid-hydrogen upper stage ready for *Surveyor* lunar landing missions in 1965.

The program's original ten-flight R&D program has been cut to eight. Two will be attempted this year; the first is expected in July or August.

Five more flights will follow in 1964, with the first *Surveyor* mission to the Moon perhaps coming early in 1965 on *Centaur 8* or *9*.

Details of the new program were revealed by Vincent Johnson, director of the project in NASA's Office of Space Sciences. It follows a high-level space agency review of the program after an unsuccessful first launch in May, 1962, and other technical and management problems that put the vehicle two years behind schedule.

Despite all its problems, Johnson said *Centaur* will still have a payload capability of over 2100 lbs. for lunar missions.

• **Revamping**—The period preceding the *Centaur* launch in mid-1963 will be used to put the vehicle through an extensive series of ground tests both at Cape Canaveral and at Lewis Research Center. An attempt will also be made to beef up some of the tank structure and to redesign structural elements of the jettisonable insulation panels.

It seems likely that the failure of the one *Centaur* launched to date was caused partly by air trapped inside the thermal insulation panels, which made them break away prematurely as the vehicle ascended.

Other recent changes in the *Atlas-Centaur* design include reduction of elapsed time from *Atlas* vernier rocket cut-off to *Centaur* ignition from 30 sec. to only 3-4 sec. Positive separation is to be assured by retro-rockets on the *Atlas* replacing the posigrade rockets on the *Centaur* stage. Reducing the staging time and shifting the weight of the separation rockets from the second stage to the booster improves performance.

New materials used in some parts of the *Centaur* stage are expected to improve structural reliability. A single-burn trajectory will be used on *Centaur* flights to eliminate the additional risk of failure in dual-burn trajectories. A non-firing *Atlas-Centaur* static test stand is being constructed at the General Dynamic/Astronautics plant in San Diego. Silverstein said NASA hopes to cut pad turnaround time at Cape Canaveral by more thorough system testing at the plant. This should also make it possible to hit narrow launch windows with greater reliability by reducing the number of component failures not detected until the rocket is on the pad. ⌗

Air Force Requests Proposals on Large Solid Boosters

THE AIR FORCE has requested proposals on development of large solid-propellant rocket boosters through a program which will see firing of four full-scale 156-in. motors in efforts to gain vital data on 260-in. powerplants for space.

Letters have gone out to qualified companies specifying work to be performed, including the firing of some 260-in. motors of sub-length design. First test in the program is due late next year.

Nozzle types will come in for considerable attention in the development effort, and movable nozzles will be pitted against jet-tab types for tests of effective thrust-vector control. Selected contractors will conduct the 260-in. firings.

The requests for proposals is the result of the AF/NASA agreement that the Air Force will conduct programs to advance solid rocket technology. The December agreement calls for ultimate development of motors 260 in. in diameter, 120 ft. long and capable of generating six million lbs. of thrust.

AF Space Systems Divisions has technical management of the program, expected to feature the following major firings, with objectives in more-than-usual detail:

• Static firing of a 156-in., single-segment motor using a movable nozzle, and developing at least one million lbs. of thrust. Scheduled to be fired for a reduced duration, the motor will simulate ignition characteristics of a 260-in. motor.

• Static firing of a 156-in., two-center-segment motor with a movable nozzle. This phase will include the firing of several sub-scale solid rockets using movable nozzles, with the aim of testing ablative and other types of extended-duration nozzles.

• Two static firings of 156-in.-dia. solid rockets, re-using the motor casing. These tests will use a single center segment, generate one million lbs. thrust, and be the first to use ablative nozzles of this size employing 1962 technology. The firing will approximate the 120-in. motor's thrust/time trace. The first firing will employ a movable nozzle, and the second will have a thrust-vector-control system based on jet tabs.

According to the Defense Department, the program will be a broad, generalized effort among several contractors attempting to answer remaining feasibility questions posed by the huge powerplants. The program is expected to "keep open the possibility of expedited development if required to meet a need for such engines in future space boosters."

Although of smaller size than the prime 260-in. motor envisioned, the 156-in. version is expected to yield necessary information on manufacturing, handling, transporting and firing motors of very large size. Until now, such considerations have been treated only in numerous technical papers—often hotly disputed. Specific components of the 260-in. motor designs will also be test-fired.

echnical Countdown

ADVANCED MATERIALS

dvanced Cooler Under Development

A miniature cryogenic cooler capable of long-term maintenance-free operation is under development by General Electric. Expected to weigh roughly 50 lbs. and occupy about 1.5 cu. ft. of space, the unit should be able to maintain a steady 4°K local environment for up to four years, developers say. A major design effort, GE reports, is circumventing the need for oil-lubricated parts used in more conventional coolers. In its developmental system, the company is employing a gas-bearing suspension for the compressor and turbine. A regenerative compressor, a miniature expansion turbine coupled to a tiny alternator and a helium gas bearing are used in one prototype.

xotic Space Alloy Can Be Machined

René 41, the high-strength nickel-base alloy used for many space and re-entry applications, can be machined readily "if the operation is deliberately executed," say engineers at General Dynamics/Pomona. During a recently completed test program, it was found that keeping cutting speeds low and chip loads high makes it possible to produce extremely deep cuts on a single milling pass through rigidly mounted material. However, they said, the margin between machining success and sudden tool failure is very slim. Tests also showed that the metal can be machined satisfactorily in all heat-treated conditions.

Space Booster Demands Heavy Heat Protection

Titan III launch facilities may be a bonanza for protective coating manufacturers. Present plans call for use of about 100,000 lbs. of heat-resistant materials applied over a 10,000-sq.-ft. area—not including the flame buckets. A three-day refurbishment requirement points to a spray-on type of coating, informants claim.

PROPULSION

100-in. Motor Tests Terminated

The recent Aerojet test of jet tabs during the firing of its four-segment, 100-in. solid motor also marked the last of the company's 100-in. rocket tests. Although over 60 seconds of meaningful test data were obtained on the tabs, the the test was terminated at about 120 seconds when the nozzle insert blew out.

Boosters Worth Saving With Soft Recovery

Recovery of large space boosters by inflatable paragliders is economically feasible if "soft" landing methods can be developed, two Space-General Corp. researchers reported at last week's ninth annual American Astronautical Society meeting in Los Angeles. Dr. R. F. Brodsky and J. D. McNerney said results of work under its current R&D contracts has led Space-General to propose that any recovery method costing less than 10% of the booster burnout weight is worth considering from an overall cost standpoint—and that the paraglider can meet this requirement. Economic feasibility of the method is based in part on "recent knowledge that booster refurbishment costs may be as low as 5% of the initial vehicle cost."

Small Rocket Yields High Thrust

NASA's *Apollo* project office in Houston has purchased the first rocket thrust chamber from Marquardt for the *Apollo* attitude control system prototype. The $11,800 molybdenum rocket is 10 in. long; its 4-in throat is coated with molybdenum disilocide. The tiny rocket, which uses UMDH and N_2O_4, produces 100 lbs. of thrust.

ELECTRONICS

Near-Maximum Laser Efficiency Possible

Lasers pumped by gallium-arsenide diodes could achieve output efficiencies of up to 85%, says Sperry Rand Research Center. Experiments by scientists at the company's Sudbury, Mass., facility using disprosium-doped calcium-fluoride lasers already promise 40-50% efficiencies. The higher figure is attainable, they claim, by pumping neodymium-doped calcium tungstate with the gallium-arsenide diodes. They say the approach is simpler, more reliable, and less expensive than attempting to directly laser the diodes alone, a feat successfully performed recently by the research team.

Manual Space Navigation Method Sought

A simple space navigation system suitable for manual operation by astronauts in emergency situations should be obtainable by extending celestial navigation techniques used on Earth, report General Electric researchers R. P. Haviland and C. M. House. Speaking before the recent American Astronautical Society meeting in Los Angeles, they said the system would use conventional navigation equipment and computing forms developed for use with tables of precomputed solutions. They claimed that investigations have shown that accurate positional information can be obtained quite readily. They recommended preparation of a special space almanac along the lines of the Nautical Almanac or the Air Almanac.

SPACE MEDICINE

Better Paste Needed for Astronauts

NASA's Manned Spacecraft Center in Houston is pressing for a better adhesive to attach electrodes to the skin of astronauts. To be used for measuring heartbeat and respiration rates during future space flights, the conductive paste must retain stability and conductivity over a long operating time period (up to several weeks). Further, it must be a non-irritant. Baylor University is presently studying the problem for NASA.

Spacemen Will Need A Measuring Rod

Astronauts will have a difficult time judging distances and closure rates in space unless they have some type of artificial ranging device at hand. Visual references such as the Earth, Sun, Moon and stars are not expected to be adequate for complete orientation where small distances or angles are involved. Subjects—some of them pilots—placed in an 800-ft.-long darkened test-chamber made errors up to 247% in gaging distances to an object, according to a study made by three Ling-Temco-Vought scientists. Some subjects became disoriented and nauseated during the tests, researchers said.

Sperry Proposes LEM Radar Sensors

Unit combines coherent pulse-Doppler, but radar use is not assured for module's landing, rendezvous

by Michael Getler

NEW YORK—A multi-purpose radar concept, designed within a single unit using state-of-the-art components and modulation techniques, is being advanced by Sperry Gyroscope Co. to meet sensor requirements for descent, landing, and subsequent rendezvous operation of the Lunar Excursion Module (LEM).

Though no firm plans have been revealed to date, several schemes reportedly are being proposed to aid in the LEM landing. These include use of laser ranging devices (M/R, Jan. 7, p. 11), use of discreet radar sensors to complement a basic inertial system, and complete radar systems.

Some engineers close to the LEM project expect NASA, in conjunction with Massachusetts Institute of Technology and Grumman Aircraft Engineering Corp., to make firm decisions on guidance in the near future.

• **Radar concept**—In putting forth the case for a multi-purpose radar system, Sperry engineers claim their single piece of equipment—weighing about 36 lbs. and occupying 0.5 cu. ft. exclusive of the 2-ft. radar dish—can provide accurate altitude, horizontal and vertical velocity, rendezvous, and local vertical data throughout the LEM mission. They say reliability, weight, and space factors are superior to those attainable through use of an assortment of discreet sensors doing the same job.

Essentially, the Sperry concept involves an X-band coherent pulse radar and a scan coherent Doppler attachment (SCODA) combined in a single unit aboard LEM, with only a radar beacon housed in the *Apollo* command module. This arrangement, Sperry asserts, also enables the LEM radar package to function as an altimeter for the entire *Apollo* spacecraft while the craft is establishing a near-circular lunar orbit prior to release of LEM.

Sperry engineers also claim inherent low-risk features for radar-derived systems; they report that malfunctions tend to be more immediately apparent than in inertial systems.

Actually, Sperry is advocating use of redundant radar packages, with one system providing data of the landing operation while the other concurrently tracks the orbiting command module. This, they claim, not only serves to increase reliability but would provide immediate tracking data on the command module should the landing radar fail during the descent. Sperry reports that either system can be reoriented to fill either role, so that an option would remain—the mission could be continued or aborted if either radar failed.

The SCODA device has been test-flown in combination with a non-coherent airborne navigation radar; results, the firm says, indicate capability to meet probable LEM requirements. The Doppler system, while primarily aimed at resolving ambiguities in the coherent pulse radar in the landing mode, is also used during rendezvous as a cross-check on range and terminal phase velocity data. The two basic modes in which the radar system operates are 1) descent and landing, and 2) cooperative rendezvous.

Choice of X-band represents a compromise in frequency between resolution demands and the ability of the radar to penetrate both the rocket plume plasma and the possible lunar dust kicked up during the final moments before touchdown. Wide choice of reliable components in this band, including klystron oscillators with good gain qualities, was also a factor.

Sperry project engineers Edward J. Gaus and John L. Martin explain the

	TO BE SENSED	RANGE	ACCURACY
APPROACH AND LANDING	ALTITUDE	120 NM to 50 ft	0.5 per cent
	LOCAL VERTICAL	±20 DEG	0.1 DEG
	LATERAL VELOCITY	6000 ft/sec to 5 ft/sec	1.0 per cent
	VERTICAL VELOCITY	1500 ft/sec to 2 ft/sec	1.0 per cent
RENDEZVOUS	RANGE	300 NM to 0	1.0 per cent
	RANGE RATE	1000 ft/sec to 2 ft/sec	1.0 per cent
	ANGLE	±100 DEG	5 mils
	ANGLE RATE	< 1 DEG/sec	0.05 DEG/sec

TYPICAL LUNAR radar sensor requirements.

	DESCENT AND LANDING	COOPERATIVE RENDEZVOUS
MODULATION TYPE	COHERENT PULSE	PULSE
ANTENNA		
Gain (db)	27	33
Beamwidth (DEG)	3	3
Wavelength (cm)	3	3
Size (ft)	2	2
High Scan Rate (rpm)	600	600
Squint Angle (DEG)	15	2
RECEIVER		
Bandwidth (Mc)		
300 NM to 0 ft	—	2.0
120 NM to 1000 ft	0.5	—
1000 ft to 50 ft	10.0	—
Noise Figure (db)	13.0	13.0
TRANSMITTER		
Peak Power (Watts)	1000	1000
Average Power (Watts)	2.0	0.2
Pulse Width (μ sec)	—	—
300 NM to 0 ft	—	2.0
120 NM to 1000 ft	2.0	—
1000 ft to 50 ft	0.1	—
REPETITION RATE (cps)	900	300

TYPICAL MULTI-PURPOSE radar characteristics.

basic radar system operation as follows:

• **Landing mode**—During approach and landing, altitude is determined by direct time measure from transmitter trigger to return, using split-gate tracking of first return. This method maintains accuracy and accommodates the extended SCODA beam pattern.

The microwave unit includes an X-band master-oscillator power-amplifier chain and a sideband generator that derives a local oscillator frequency from the transmitted signal for receiver mixing. This avoids potential reliability problems with use of a search-type automatic frequency control. Receiver gain is controlled automatically by a sensitivity-time-control circuit that sets gain as a function of time. This is augmented by an automatic gain control.

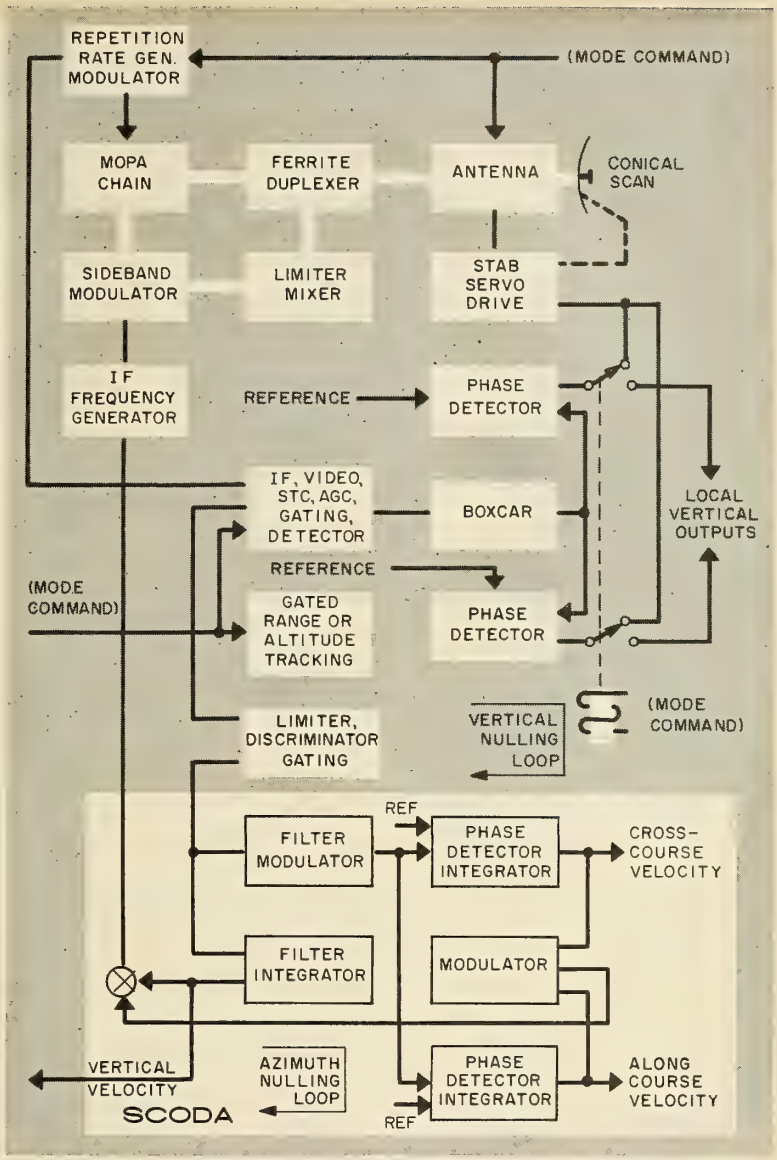
IF bandwidth, adjustable to the mission phase, need only be sufficient to pass the spectrum needed for the desired pulse shape, because, Gaus and Martin report, side-stepping for the LO minimizes drift. Circulator duplexing is used in conjunction with an RF limiter for proper receiver isolation during transmission and rapid recovery. Also, they point out, reliability is improved by eliminating gas duplexers.

The 2°-of-freedom, mechanically rotatable, paraboloid antenna has a 2-ft. dish which is modified to broaden part of the beam characteristics to assure receipt of reliable, unambiguous, first-return altitude data together with SCODA-derived velocity. The dish is stabilized to local vertical during descent, and to vehicle reference during rendezvous.

SCODA uses a discriminator, range-gate, filters, scan-coherent phase detectors, and integrators. To minimize noise and drift, Doppler nulling loops are used, controlled by driving the IF reference to remove Doppler shifts. Velocity readout is stored in stand-off integrators.

Local vertical is arrived at by gating some of the early returns and sampling the changing amplitude as a function of scan angle. The amplitude is a function of the amount that the vehicle is off vertical and is phase-related to the direction of this amount. The phase of the off-vertical signal is compared to the scan references in two phase detectors. Using the detector outputs, the off-vertical error is nulled by changing the attitude of the antenna or vehicle.

After altitude has been established, the velocity sampling gate is positioned at a present delay beyond the track altitude. This delay is proportional to the off-vertical angle, and its value is determined by two factors: 1) scattering coefficient, and 2) Doppler-return sensitivity. Velocity gate width is determined by the interplay of allowable



BLOCK DIAGRAM shows major subsystems of dual-mode Sperry radar.

Doppler spectrum spreading, return sensitivity, signal integration, and system BW. The local vertical gate is positioned near or at signal threshold. This, Gaus and Martin point out, is particularly important for sensing relative amplitude modulation, since the antenna beam gain slope is greatest there.

Transmitter power was chosen, they report, to permit acquisition and lock at maximum operating altitude, where terrain perturbations appear small, without inertial mixing (but power can be conserved if altitude is derived inertially). For lower altitudes and final stages, the altitude tracking system must have a dynamic response sufficient to follow expected ground variations.

• **Rendezvous mode**—In rendezvous mode, using the beacon, range is determined in the same basic manner as altitude; and modification for split-gate tracking of equal energy return, transponder delay, and offset reply frequency are easily made, Sperry reports. Range rate is derived from range error in the tracking loop.

During beacon operation, SCODA is used only as a gross range check, since any mutual drift in the two transmitters represents Doppler error. However, during the terminal rendezvous maneuver SCODA can be used as a velocity sensor with the addition of an auxiliary horn, a mixing stage, and filtering that rejects the beam's offset frequency return and accepts only the coherent direct transmitted reflections. ⁂

Apollo Life-Support Problems Probed

Atmospheric control, management of wastes still to be solved by NASA

by Heather M. David

ATMOSPHERIC CONTROL and management of metabolic wastes remain the biggest life-support problems in the *Apollo* project.

While the 100%-oxygen, 5-psia environment of Project *Mercury* has been approved for the longer flights, long-duration tests have been marked with minor incidents.

Some physical symptoms—slight changes in the blood and loss of peripheral and night vision for 36 hrs. after return to normal atmosphere—occurred during the tests at the Navy's Air Crew Equipment Laboratories, and at Republic Aviation Corp. NASA officials, however, said they felt the atmosphere was safe.

One hazard of the 100% oxygen capsule is the increased danger of fire. Two fires occurred during the NASA tests. The School of Aerospace Medicine last year had the same experience. Although inclusion of an inert gas would not eliminate the danger of fires, the mixed atmosphere would not support fire as well as oxygen does.

NASA life-support officials R. S. Johnston and E. L. Michel recently told the American Assn. for the Advancement of Science that materials and design of systems were being carefully chosen to eliminate sources of combustion.

NASA has decided against a regenerative-type oxygen system, saying that weight trade-offs were not justified. Oxygen for both the environmental-control system and the electrical power-producing fuel cell is stored in the supercritical state.

According to the engineers, a coolant loop connected to a space radiator will remove heat from the system. Condensed water collected in the system will be used for high-temperature periods, using an evaporative heat-exchanger system.

Drinking water will come from water produced in the fuel cell.

Trace contaminants will be controlled by a catalytic burner if necessary. Activated charcoal will be used for odor removal.

• **Spacesuit data**—The *Apollo* spacesuit was described as "the most complicated suit and supporting equipment development program ever attempted." Pressure protection is a vital factor, and reliability must be more than 9^3. In hardware units, say NASA officials, this reliability can be assured, but present spacesuits are subject to accidental tears.

The *Apollo* suit will therefore have "underwear"—a pressure suit within a suit. It will reduce mobility somewhat, but joint construction—described as a constant volume bellows—is said to be very efficient. Advantage of this type of arm and leg joint is that it does not require energy to compress the pressurizing gas.

Discovering how to control the temperature inside the pressure suit with an active man inside it is one of the puzzling problems NASA faces. Little data is available on what the temperature is inside a spacesuit. A program is under way now to determine it.

The one-sixth gravity of the Moon is a factor that must be considered in maintaining temperature balance. Expert opinion now says that metabolic output on the moon will probably be halfway between normal gravity and weightlessness.

Estimating the amount of heat the astronaut would get from the Moon is another puzzler.

NASA engineers figure that he will get direct solar heat, lunar-emitted heat, lunar-reflected heat, crater-emitted heat, and crater-reflected heat. After figuring approximately how much this will total, they conclude that the suit's surface temperatures can be withstood by within current materials. However, the portable life-support system will have to remove about 120 Btu/hr more than the crewman's anticipated metabolic rate.

The portable life-support system the *Apollo* astronaut will use on his four-hour egresses to the Moon will be essentially a miniaturized *Mercury* spacecraft closed-loop system.

• **Gemini spacesuit**—A unique feature of the *Gemini* spacesuit is that portions of it—such as heads, arms and legs—can be detached.

The torso section will always be worn, however, and the other sections can be put on rapidly during emergency periods.

The suit differs from the *Mercury* suit in that oxygen enters the waist into a chamber that distributes it directly to the head, arms and legs, then exits at the waist. In *Mercury*, the gas exited through the helmet, and there was more danger of inhaling toxic gases and body odors.

NASA is beginning evaluation programs to determine water requirements and metabolic outputs of the *Gemini* astronauts in their various phases of spacesuit dress. Other tests are underway to assess how well the men endure the spacesuit for extended periods of time—two, seven and 14 days.

• **Food and waste**—Freeze-dried dehydrated food is being considered for the *Apollo* trip. About 95% of the water can be removed from food in this manner, while 85%-90% is removed by hot-air drying. Water would be added when used. Some snack items in edible packages may also be carried.

NASA is now investigating ways of operating a toilet-type facility for the *Apollo* command-module. *Gemini* waste-management will be accomplished by using collection bags, since crewmen will wear pressure suits (at least the torsos) at all times.

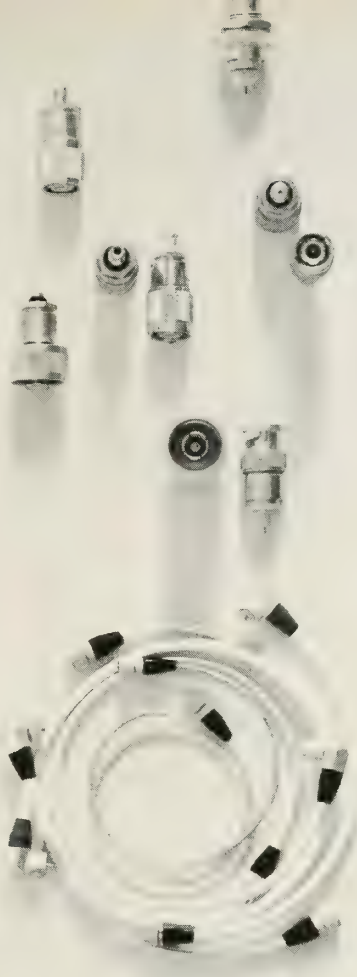
• **Bioinstrumentation** — Although bioinstrumentation will be required in the early, Earth-orbiting flights, it will be reduced in the later flights. After crew validation for the 14-day weightless flight is accomplished, NASA said, the crews will do much of their own monitoring with simple clinical devices.

NASA described another phase of the program that has made great strides —that of water-survival equipment for return to Earth. The engineers said that new fabrication techniques for inflatables have made it possible to design a life vest that would keep an astronaut afloat even if his suit were completely filled with water.

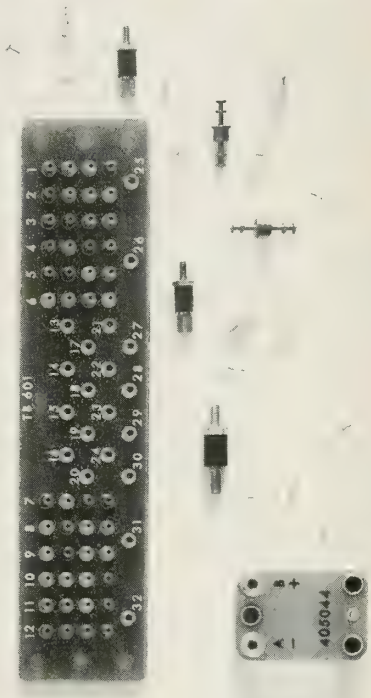
Another development along this line is a life raft so stable it would support a man standing on its rim without capsizing, reducing danger when transferring craft. A radar reflector that packages in a ½x3x6-in. space, and weighs only two ounces also has been developed. Only three breaths will be required to inflate this reflector to 39 in., and it can be tracked by radar within a 50-mile radius. ⁂

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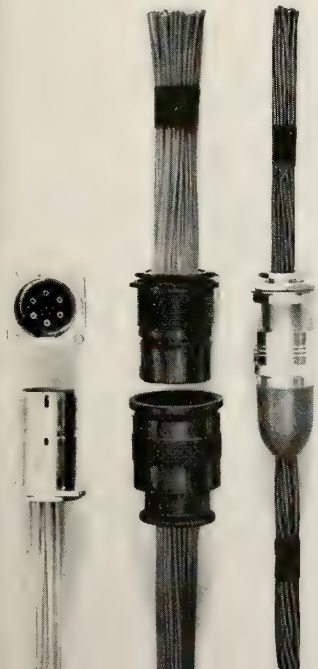


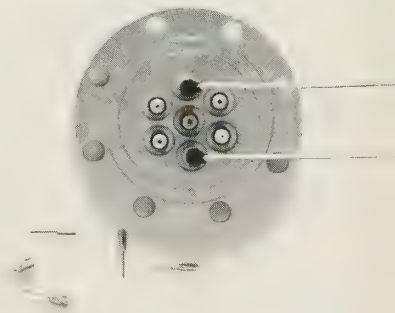
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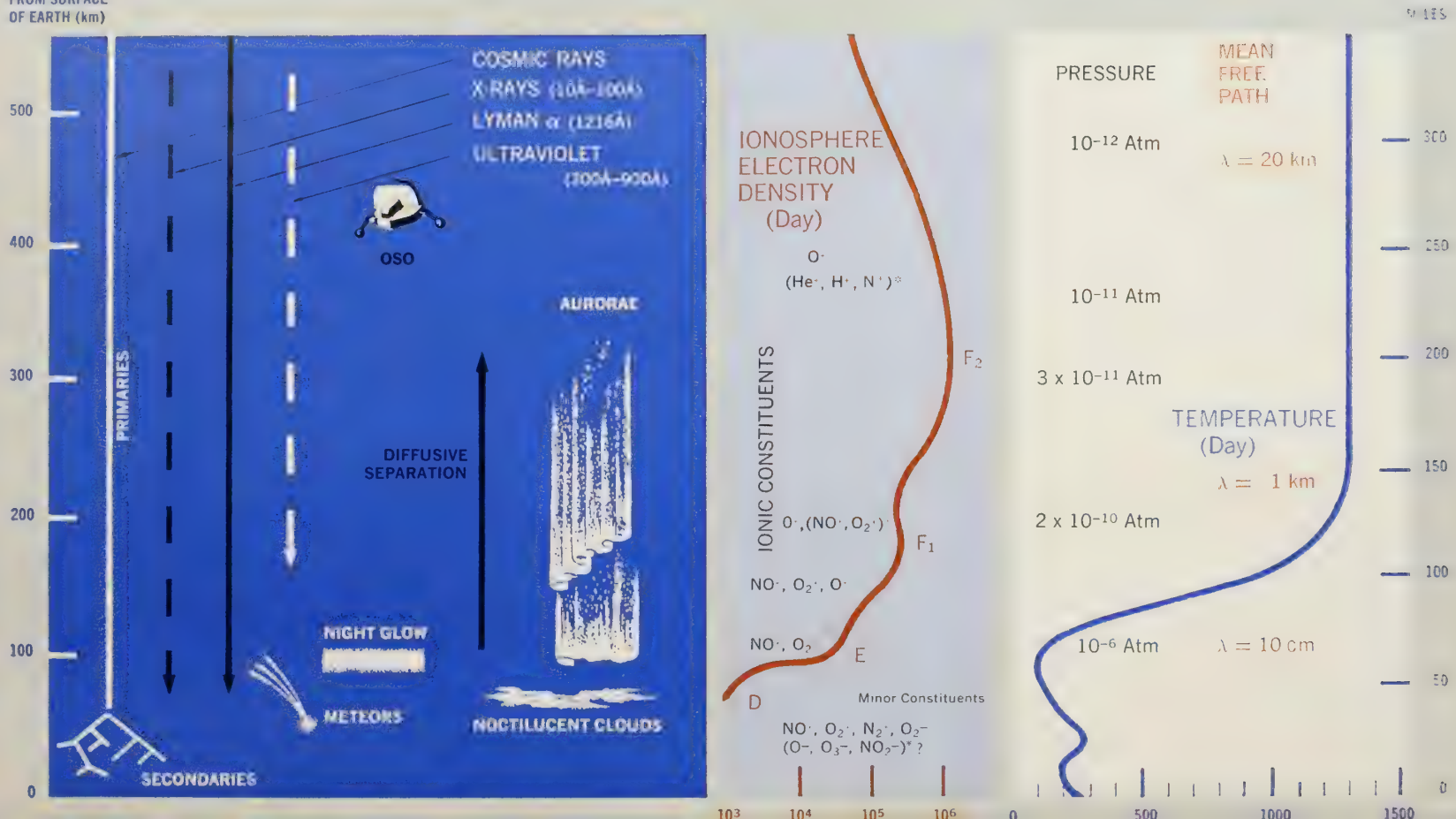


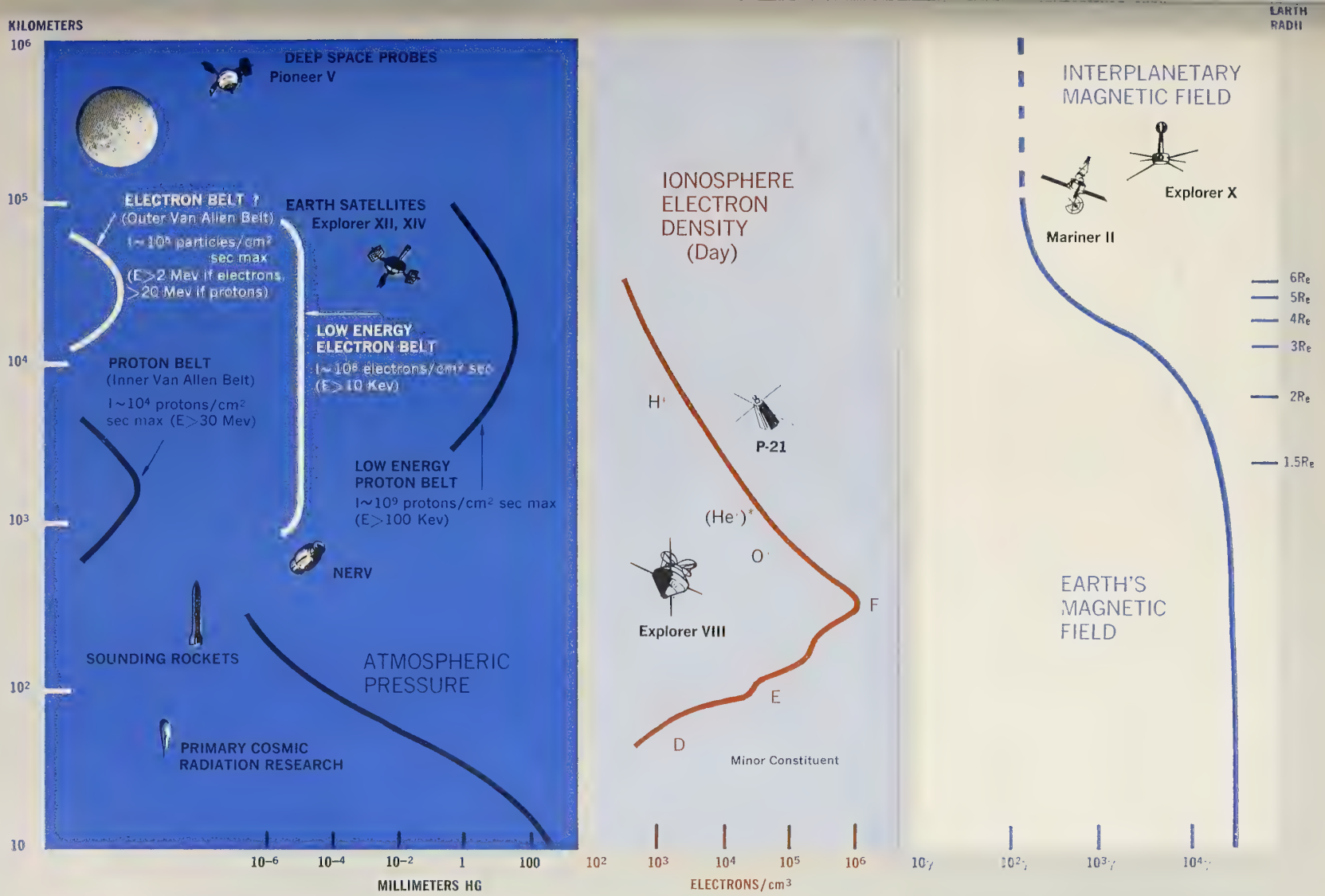
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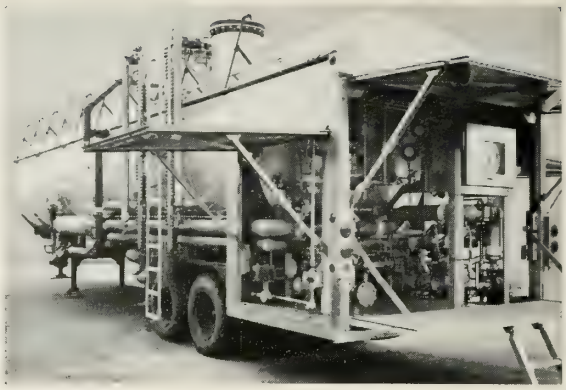
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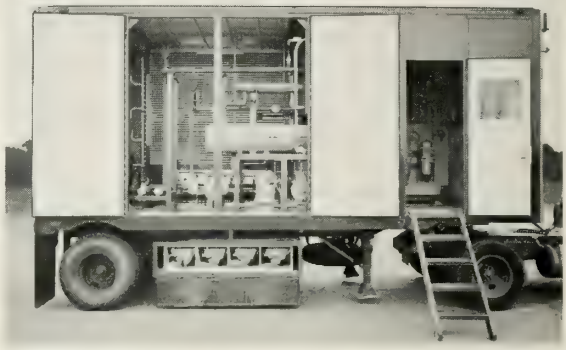




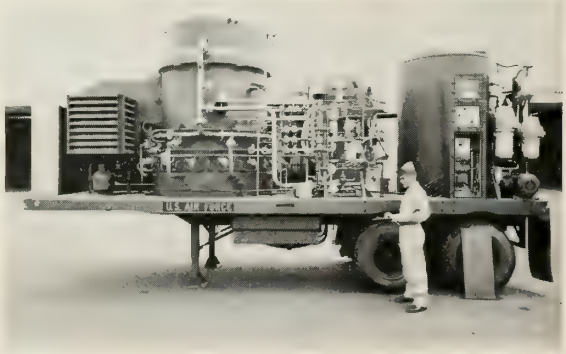
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Circle No. 9 on Subscriber Service Card

NASA To Develop Solar Probe Craft

NASA SOON WILL BEGIN the development of a solar-probe spacecraft designed to measure interplanetary phenomena at distances of up to 50 million miles from Earth.

The 120-lb. spacecraft series—dubbed *Pioneer*—will be launched as part of this country's participation in the International Year of the Quiet Sun. Four will be built, with the first flight scheduled for late 1964.

The program has already been approved by Associate Administrator Dr. Robert C. Seamans, Jr. A request for proposals from industry is expected in a matter of weeks, a NASA official told MISSILES AND ROCKETS.

Only about $4 million is available for the program in Fiscal 1963. Its total cost is estimated at over $30 million, with slightly over $20 million earmarked for the spacecraft and the remainder for required launch vehicles.

While only four flights have been approved, officials of NASA's Office of Space Sciences have plans for three more. This would push total costs to over $45 million, with launches extending into the 1967-68 period.

The project will be directed by the Ames Research Center. Goddard Spaceflight Center will be responsible for launch vehicle development and procurement.

• **Objectives**—Primary purpose of the probe is to study solar flares. Other objectives of the *Pioneer* flights include measurements of interplanetary magnetic fields, galactic cosmic radiation and micrometeoroids.

The probes will also provide, in conjunction with presently scheduled *Mariner* spacecraft, simultaneous measurements at widely separated points in interplanetary space. In addition to serving as a backup to the *Mariner* mission, *Pioneer* will provide data required by Project *Apollo*.

Pioneer will be launched by a *Thor-Delta* booster into an elliptical orbit around the Sun.

The spacecraft will be spin-stabilized. After separation, the spin axis will be reoriented, in the direction normal to the plane of the ecliptic, by a gas-jet system. The high-gain antenna would be designed to radiate approximately in the plane of the vehicle's equator, i.e., in the ecliptic plane, when the spin axis is nominally oriented. It is estimated that a gain of 10 db will be provided in the region within 3° of the vehicle's equatorial plane. Omnidirectional antennas would be carried also.

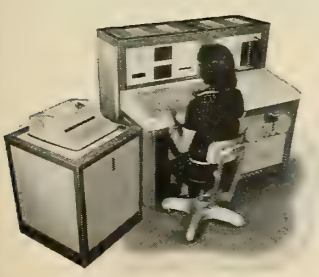
Data will be transmitted to the Deep Space Instrumentation Facility by means of an amplitron-powered transmitter operation at 3300 mc. With 10 watts of rf radiated, the spacecraft-ground link will provide information at a rate of 20 bits per second at a range of 50×10^6Km, the nominal range after 6 months of the flight. The spacecraft transmitter will operate continuously at data rates selected by ground command. The system will include provisions for a small number of other ground commands, including those to effect spin axis reorientation, and power level of radiated rf. Power will be provided by solar cells. Thermal control can be provided by an active or passive system. Capability of data storage up to 6000 bits is being considered. ⌘

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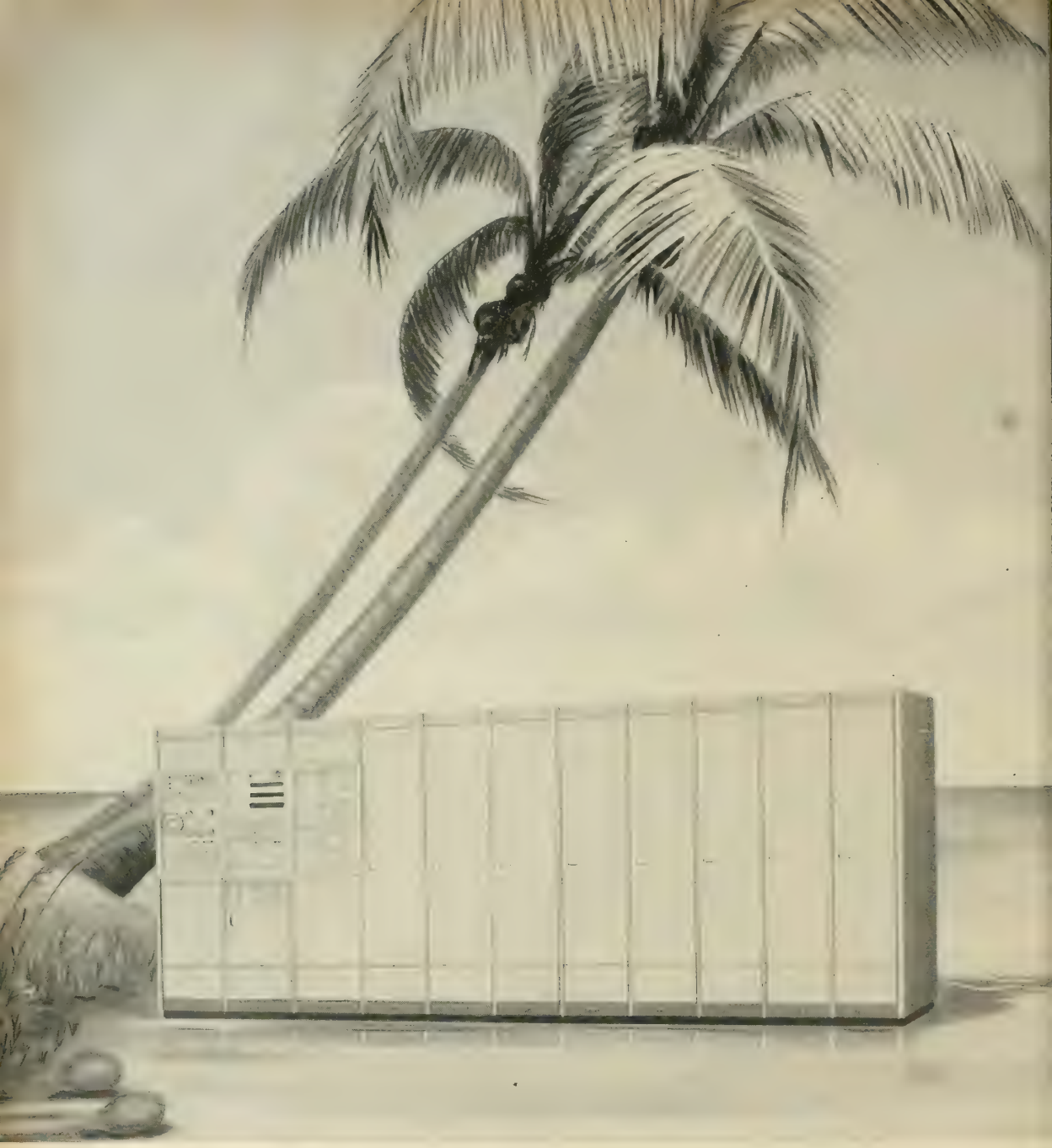
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Research Uncovers Asbestos Potential

Missile/space specifications may hamper development of more versatile grades

by B. F. Douglas
Group Leader
Reinforced Plastics Research
Taylor Corp., Valley Forge, Pa.

ASBESTOS-REINFORCED PLASTICS may not be realizing their full potential in nose cones, solid motor chambers and other vehicle components because of a blind adherence to one type of basic asbestos—the long spinning grade.

Virtually every specification in the missile/space field calls for this grade, but research at the Taylor Corp. indicates other types of absestos reinforcing may out-perform the long fiber material in many applications.

The basic cause for prevalence of the long spinning grade in aerospace applications is industry inexperience with the various forms in which reinforcing asbestos can be supplied, coupled with too little research on the effects of their properties on the end product.

The more immediate cause seems to be founded on a series of assumptions going something like this:

—Cloth can be made only from the long spinning grades of asbestos.

—The strongest asbestos-reinforced plastic is that made with asbestos cloth.

—Strength is the most important characteristic of reinforced plastic components.

—Therefore, all orders for asbestos-reinforced plastic in the aerospace field should specify the long spinning grade of asbestos.

When development of the Tayloron line of reinforced plastics for high temperatures was initiated, Taylor researchers evaluated all forms of asbestos. Chrysotile (long grade) and crocidolite—an amphibole of the hornblende group—were investigated. The latter is short-fibered and not amenable to waving, but has other properties advantageous to high-temperature applications.

Researchers questioned the whole set of premises leading to the selection of the long spinning grade. Some notably weak links were uncovered. Only the premise claiming that cloth could be made from the long spinning grade held up without qualification.

• **Composite considerations**—While cloth itself is stronger than asbestos paper or asbestos mat, it was suspected this might not necessarily hold true when the base materials were impregnated with resin and either laminated into sheets or processed into molding materials.

Further, while the longer fibers available in chrysotile allowed production of reinforcing materials stronger than those which could be made from shorter-fiber crocidolite, weaving the fibers into cloth would not necessarily produce a stronger reinforced plastic.

In the table, for example, note that the Tayloron reinforced plastic made

Typical properties of asbestos-reinforced plastics for ablation and thermal insulation requirements. Typical properties based on ¼ in. thickness.

Properties		Tayloron 5033		Tayloron 5031		Tayloron PA-6		Tayloron P-A	
		Cloth made with chrysotile and nylon		Paper made with crocidolite nylon and nitrile rubber		Paper made with highly purified chrysotile		Mat made with refined chrysotile	
Base material		Laminated Sheet	Molded Section	Laminated Sheet	Molded Section	Laminated Sheet	Molded Section	Laminated Sheet	Molded Section
Specific Gravity		1.35	1.38	1.34	1.33	1.70	1.70	1.55	1.57
Water Absorption (% by wt.)		1.50	0.22	0.21	0.19	0.50	0.55	0.51	0.55*
Ultimate Flexural Strength (psi)	Lengthwise	11,000	6,500	12,000	8,000	39,000	15,100	26,000	13,300
	Crosswise	10,000		10,000		25,000		19 500	
Ultimate Flexural Modulus (psi)	Lengthwise	0.6×10^6	0.6×10^6	0.6×10^6	0.5×10^6	3.2×10^6	1.9×10^6	1.1×10^6	1.3×10^6
	Crosswise	0.6×10^6		0.5×10^6		1.9×10^6		0.7×10^6	
Ultimate Tensile Strength (psi)	Lengthwise	5,500	3,000	7,500	4,500	29.000	8,600	20.500	7,300
	Crosswise	5,500		6,500		17,600		12,000	
Ultimate Tensile Modulus (psi)	Lengthwise	0.8×10^6	0.8×10^6	0.7×10^6	0.7×10^6	3.3×10^6	2.2×10^6	3.1×10^6	1.7×10^6
	Crosswise	0.8×10^6		0.7×10^6		2.1×10^6		2.0×10^6	
Ultimate Compressive Strength (psi)		22,000	19,000	24,000	21,000	55,000	53,000	48,000	39,500
Ultimate Compressive Modulus (psi)		0.3×10^6	0.3×10^6	0.3×10^6	—	0.82×10^6	0.72×10^6	0.79×10^6	0.7×10^6
Shear Strength (psi)	Perpendicular to laminations	10,000	—	11,000	—	16,000	—	17,000	—
	Parallel to molding force	—	8,500	—	10,000	—	18,000	—	13,600
Izod Impact Strength (ft.-lb./in. of notch)		3.0 x 2.6	2.7	1.3 x 1.3	1.2	2.3 x 1.3	1.4	2.9 x 2.4	1.6
Rockwell Hardness		M-70	M-60	M-90	M-85	M-115	M-113	M-115	M-111
Thermal Conductivity (Btu in./ft²/hr./°F)	150°F	1.21	1.07	.58	.80	.89	.69	.82	.42
	200°F	1.15	1.20	.71	1.10	.97	1.10	.91	0.96
	250°F	1.22	1.08	.81	1.10	.87	1.18	.83	1.03
Specific Heat (Btu/lb./°F)		.38	.39	.34	.36	.27	.24	.31	.40
Diffusivity (250°F) (ft.²/hr.)		.0032	.0027	.0024	.0028	.0025	.0039	.0023	.0022
Coefficient of Linear Thermal Expansion (Range: —30° to 30°C)	Lengthwise (in./in./°C)	2.79×10^{-5}	3.62×10^{-5}	$.36 \times 10^{-5}$	3.54×10^{-5}	$.99 \times 10^{-5}$	1.18×10^{-5}	$.84 \times 10^{-5}$	2.09×10^{-5}
	Crosswise (in./in./°C)	—		—		1.58×10^{-5}		$.57 \times 10^{-5}$	

from asbestos paper has better lengthwise ultimate flexural strength and ultimate tensile strength than the Tayloron grade made with asbestos cloth.

Another factor affecting the strength of the reinforced plastic is whether asbestos is used alone as the reinforcement or whether it is combined with another material. Note in the table that the two grades made with pure asbestos have much higher mechanical properties than the two grades that combine nylon with asbestos as the reinforcing material.

Nylon has better mechanical properties than asbestos, but the resin used in the reinforced plastic does not wet the nylon nearly as well as it wets asbestos in the coating process. This is one reason the impregnated material using only asbestos is stronger than the other. Another reason has to do with the modulus of elasticity of the two materials. In composite structures, use of the two materials with different elongation behavior under applied force may result in a structure in which the two reinforcing agents do not work together.

Thus asbestos, which fails under applied forces at a relatively low elongation compared to nylon, will carry the applied load by itself with only partial contribution from the nylon. This is further proof that in a complex system like reinforced plastics, the properties of the components cannot be used to calculate the properties of the end product but must test the product in the form in which it will be actually used.

The next questionable premise is that strength is the most important characteristic in a reinforced-plastic part for a missile, rocket or space vehicle. If that were true, there would be no reason to combine asbestos with nylon, since reinforced plastic made with both materials is not as strong as that made with asbestos alone. But nylon contributes some very useful properties to the final material. For example, it reduces weight, provides better char formation and better heat-sink characteristics through depolymerization.

The importance of strength in the reinforced plastic is also lessened by the fact that the plastic is frequently combined with other materials, such as metals, which provide the needed strength. The primary function of the reinforced plastic is to provide thermal insulation, and good ablation properties in some applications. Its strength is usually a secondary consideration.

• **Reliability in paper**—When choosing material for an aerospace application, its uniformity or reproducibility is of utmost importance.

With this in mind Taylor researchers turned their attention to asbestos paper for reinforcing high-temperature plastics, since past experience in manufacturing paper for reinforced plastics showed that the paper production can be closely controlled, and that an outstanding characteristic of paper is its uniformity.

The consistency of asbestos paper as a reinforcing material eliminates thin and thick spots, and there is far less chance of having resin pockets when pre-preg material using asbestos paper is macerated into molding material. Moreover, paper-base materials are easier to macerate. Their use eliminates the possibility of ending up with unmacerated fabric. The superior uniformity of the materials made with asbestos bases allows maximum preheating temperatures when molding.

Freedom to work with more than just the long spinning grades of asbestos —that is, with crocidolite as well as chrysotile—has a number of advantages for both the reinforced-plastic supplier and his customers. For example, he has greater flexibility in selecting his sources of supply for asbestos. This puts him in a better position to maintain the quality standards required by the aerospace industry.

• **No metal inclusions**—Greater latitude in choice of materials and suppliers also makes it easier to furnish molding materials with no metal inclusions. This in turn makes it easier for the molder to certify that there are no metal inclusions in the finished missile or rocket part.

Manufacturers of asbestos-based reinforced plastics can guarantee their product is free from metal inclusions only if they are allowed freedom in choosing type of asbestos and length of fiber, and also in the cleaning and manufacturing procedures.

This freedom of choice can also improve ablation properties. It has been reported that reinforced plastic made with crocidolite asbestos has better ablation properties than that made with chrysotile, and this may be related to the fact that crocidolite contains considerably less water of crystallization. In some applications, then, asbestos reinforcement made from crocidolite may perform better than that made from chrysotile.

When molding parts from asbestos-reinforced plastics, medium-or-short length fibers have definite advantages over long-length fibers. The longer the fiber, the greater its tendency to cluster into a mass or ball, hence the poorer its molding properties where flow is required.

Molding materials made from prepreg materials using an asbestos-paper base are generally superior to those using asbestos-cloth, not only because paper has no long fibers to agglomerate but also because it is easier to control the uniformity of paper than that of cloth or non-woven mat.

Specification of a long spinning grade of asbestos for high-temperature reinforced plastic is highly questionable in the case of molding materials that have good flow characteristics. Generally, the shorter the fiber the more uniform the distribution and the better the flow characteristics.

• **Taylor's conclusions**—Work with asbestos-reinforced plastics for aerospace applications, both in the development of materials and in their production, has led Taylor researchers to the following conclusions:

—There is only one reason to specify long fiber length—to permit weaving the asbestos into cloth.

—Long fibers allow production of stronger reinforcing materials than do short fibers, but a reinforced plastic, whether laminated or macerated into a molding material, is not necessarily stronger when made with asbestos cloth than when made with asbestos paper.

—Strength is not always the most important consideration when specifying a reinforced plastic for a missile, rocket or space vehicle. Light weight and good ablation and heat-sink characistics may be equally or more important.

—Greater uniformity of end product is possible when a reinforced plastic is made with asbestos paper.

—Molding materials reinforced with medium- or short-length asbestos fibers have better flow characteristics than those made with long fibers.

—Elimination of the specification for "long spinning grades" when ordering asbestos-reinforced plastic parts gives the plastic manufacturer more freedom in his choice of the type of asbestos for reinforcement and gives him a better opportunity to meet the quality standards of the aerospace industry. It may even help him provide a better product, since crocidolite (not available in long-fiber form)is reported to have better ablation properties than chrysotile.

Putting the form of asbestos in its proper perspective should free designers of missile and spacecraft components to specify the best reniforced plastic for the job without regard to whether the asbestos used in it is chrysotile, crocidolite, short fiber or long fiber.

The form of asbestos used should be the problem of the reinforced plastic manufacturer; the concern of the missile engineer is more logically whether or not the end product (reinforced plastic) meets his requirements. ⌗

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NUCLEAR POWER SYSTEMS. SNAP generators for land, sea, and space systems—world's first in space, first undersea, first lighthouse, first weather station. Portable reactors at Sundance, Wyoming, and South Pole.

AIR DEFENSE AND COMMUNICATIONS. Missile Master and BIRDiE electronic air defense systems operational in 29 major metropolitan areas. RACEP communications system, providing direct-dialing, telephone-type service for 700 simultaneous conversations on a single frequency channel without wires or central switchboard. Missile command and control systems, ASW systems.

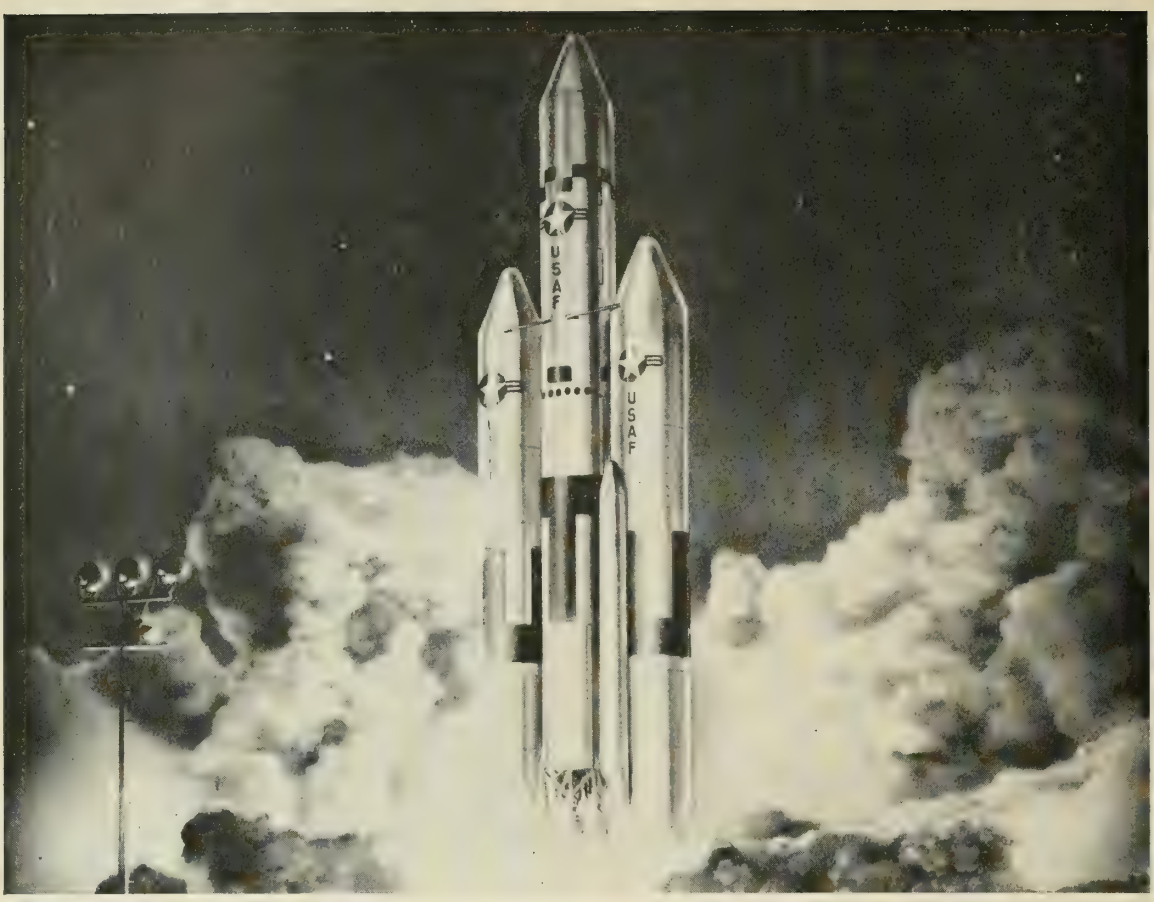
MATERIAL DEVELOPMENT. Exotic materials, with high heat flux, high strength with low weight. First production technique for fusion welding of high-strength aluminum alloy. Isotopic fuel forms, tubular fuel elements. Semiconductor materials research, microelectric elements, cryogenics, ceramic heat shields, plastics, surfex, molybdenum honeycomb.

APPLIED RESEARCH. Advanced work in hypersonic aerodynamics. Cryogenics, lasers, masers, celestial mechanics, guidance, quick reaction controls, stability, structures, millimeter wave theory, thin films, infrared detectors, computer technology, thermoelectricity, mission simulation, mathematics, checkout systems, advanced fabrication, solid state.

SYSTEMS MANAGEMENT. In the past five years, 1957 to 1962, Martin has delivered $3 billion in total contracts. $2.9 billion were completed at or under contract cost. $2.8 billion on or ahead of schedule.

At Martin, systems management means the best possible product at the lowest possible cost in the shortest possible time.

MARTIN MARTIN MARIETTA



THIS IS TITAN III United Technology Center is now at work on development of the first or solid booster stage for the Air Force Titan III. UTC's huge segmented solid propellant rocket motors, each 120 inches in diameter and producing more than a million pounds of thrust, will blast the Standardized Space Launch Vehicle from its launch pad. Titan III, with all stages assembled, will stand more than 100 feet tall on the pad, and will be utilized to put multi-ton payloads into orbit. These payloads will include the X-20 Dyna-Soar.

THIS IS UTC United Technology Center has important positions available now for scientists and engineers with experience in rocket propulsion and related technologies. This young and dynamic division of United Aircraft is one of America's fastest-growing aerospace organizations. In UTC's unique professional atmosphere, you'll find broad opportunities for advancement. You will work with men preeminent in rocket propulsion. Enjoy the many technical facilities of UTC's Research and Engineering Center and sprawling test site. That's not all. Here are a few of the other rocket motor projects . . . in addition to Titan III . . . now underway to challenge your imagination and scientific skills.

UPPER-STAGE LIQUID MOTORS • HYBRID MOTORS • FILAMENT-WOUND MOTOR CASINGS • ABLATION-COOLED THRUST CHAMBERS • VARIABLE-THRUST CONTROL SYSTEMS • THRUST VECTOR CONTROL SYSTEMS

If you have experience in such areas as weapons systems project planning, chemical process operations, testing of liquid and solid propellant motors, design of test instrumentation and reliability analysis, there's a good chance you'll find the ideal position at UTC. Drop a line or send your resume today.
Contact Jay W. Waste, Department 27B, P. O. Box 358, Sunnyvale, California

DIVISION OF UNITED AIRCRAFT CORPORATION

UTC **United Technology Center**
(Formerly United Technology Corporation)

The Industry Week

Industry Facilities

Cannon Electric Co. has moved its Magnetics Div. from Glendale to Anaheim, Calif. The new, larger quarters include clean-room modules for solenoid development and manufacture. . . . *Indiana General Corp., Valparaiso, Ind., has opened a new area sales office in Ann Arbor, Mich. IGC's product lines include digital computer memory systems, permanent magnets, ferrites and miniature precision motors.* . . . Aircraft Armaments, Inc., Cockeysville, Md., is beginning construction of a manufacturing addition to its main plant. To be constructed by Ira C. Rigger, and scheduled for initial operation in March, it will accommodate a 40% increase in staff expected by the middle of this year. . . . *A newly opened Washington, D.C., office of Electronic Associates, Inc., will be devoted to handling the company's line of general- and special-purpose analog computers. Axel Anderson will manage the new office.* . . . CPR International Corp. has completed the second of three phases of a 175,000-sq.-ft. physical facilities expansion program at Torrance, Calif. ABCO of Beverly Hills, Calif., is construction contractor, and William R. Reidenbach is architect. CPR manufactures technical urethane formulations for atomic energy, missile/space and general industry applications. Expansion provides added space for production, warehousing, research and development functions. It also allows for establishment of a new packaging division with complete testing facilities. . . . *VSI Corp. is establishing a manufacturing facility near Brussels, Belgium, to extend the firm's production and marketing of precision fasteners of exotic materials. To be operated by VSI's Voi-Shan Manufacturing Co. Div., the European plant is scheduled to begin production this spring.*

Mergers & Acquisitions

General Controls Co., Glendale, Calif., will be merged into the International Telephone and Telegraph Corp., pending approval by stockholders of both companies. GCC produces automatic controls for missile/space and other applications, employs 3000 persons, and has facilities in California, Illinois and Rhode Island, as well as in Ontario, Canada, Dusseldorf, West Germany, and Essex, England. Merger involves a stock-exchange transaction. . . . *Aerotest Laboratories, Inc., Deer Park, N.Y., has acquired Northeastern Testing Laboratories, Inc., formerly known as Eastern Testing Laboratories. The firm was acquired from General Magnaplate Corp., Belleville, N.J., for an undisclosed amount of stock.* . . . Packard Bell Electronics has sold its Bellwood Div. to Angelus Industries, Inc., for approximately $1 million. Purchasing firm is located in Beverly Hills, and the Bellwood Div. is in Orange, Calif. . . . *ChemTrac Corp., producer of certified tagged chemicals, has become a wholly owned subsidiary of Baird-Atomic, Inc., Cambridge, Mass. ChemTrac's management, laboratory, and manufacturing functions have been moved to Baird-Atomic's Cambridge facilities.* . . . National General Corp. will acquire Mobile Rentals Corp. through stock exchange on a share-for-share basis. Mobile Rentals is a Los Angeles, Calif., designer-producer of mobile units for industrial applications. . . . *Baldwin-Lima-Hamilton Corp. has purchased Green Fuel Economizer Co., Beacon, N.Y., designer-manufacturer of industrial fans. BLH says the purchase will complement a product line that now includes heat exchangers, hydraulic turbines and nuclear components. Purchase price was not disclosed.*

New Units Formed

Land-Air, Inc., and Mattern Corp., two wholly owned subsidiaries of Dynalectron Corp., have been merged into the parent company. The resultant change in the firm's structure has the effect of establishing eight new direct divisions of Dynalectron. They are: Mattern Div. (formerly Mattern Corp., Chicago); Land-Air Div. (formerly the White Sands-Holleman Div. of Land-Air, Inc.); Cheyenne (Wyo.) Div.; Industry Services, Inc., Div. (Arlington, Va.); Instrument and Electronics Div. (San Leandro, Calif.); Aerospace Operations Div. (formerly Field Operations Div., Chicago); Paradyn Div. (Pt. Mugu, Calif.); and Stepper Motors Div. (Gardena, Calif.). . . . *Sanders Associates, Inc., has set up a new Corporate Advanced Program Development Group to serve long-range needs related to Sanders' rapid growth into multi-plant engineering operations. Key personnel from throughout the company will be assigned to CAPD, reporting directly to Martin R. Richmond, corporate vice president, who will direct the group.* . . . Daystrom, Inc., has formed a new Weston Instruments and Electronics Div., made up of its former Military Electronics Div., Archbald, Pa., and Weston Instruments Div., Newark, N.J. Aims of the merger are greater engineering depth, increased laboratory and test facilities, broader marketing coverage and better marketing control, as well as greater management centralization at the Newark offices. . . . *Ling-Temco-Vought Inc.'s Temco Electronics Div. has set up a separate research and development department to work in general electronics, automatic controls and guidance, aerospace ground equipment and communications and tracking. The department will coordinate its programs with the LTV Research Center and other R&D activities within the firm.* . . . Bell & Howell's Consolidated Electrodynamics Corp. is expanding its Technical Supplies Dept. The 2½-year-old unit, until now primarily marketing instrumentation magnetic tape and oscillograph recording paper and chemicals, now is expected to diversify its line of products and its sales programs. Nicholas Vracin has been named head of the department, will oversee the expansion.

AWARDS

AIR FORCE

$4,500,000—**Mitre Corp.,** Bedford, Mass., for systems engineering and technical development of command and control systems.

$4,366,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space systems (two supplemental contracts). Work to be done at Sunnyvale, Calif.

$3,800,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for space vehicles. Work to be done at Sunnyvale, Calif.

$3,318,445—**Philco Corp.,** Philadelphia, for work on space programs. Work to be done at Palo Alto, Calif.

$3,000,000—**Douglas Aircraft Co., Inc.,** Tulsa, Okla., for converting the first increment of 15 *Thor* IRBM's to a space-booster configuration.

$3,000,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for work on space systems.

$2,000,000—**General Precision Inc., General Precision Aerospace,** Little Falls, N.J., for work on guidance and control system of *MMRBM*.

$1,613,700—**Mitre Corp.,** Bedford, Mass., for systems engineering for command and control systems (supplemental contract).

$1,570,000—**Army Corps of Engineers,** for construction of ballistic missile re-entry system launch facilities. Work to be done near Green River, Emery County, Utah.

$1,500,000—**Avco Corp.,** Wilmington, Mass., for research and development on re-entry vehicles.

$1,500,000—**Philco Corp.,** Philadelphia, for work on space systems. Work to be done at Palo Alto, Calif.

$1,482,000—**General Electric Co.,** Syracuse, N.Y., for operation and maintenance of radar equipment.

$1,478,000—**Acoustica Associates, Inc.,** Los Angeles, for propellant utilization systems engineering on the *Atlas* missile program.

$1,470,000—**United Technology Center,** Sunnyvale, Calif., for providing services in connection with the installation, checkout and instrumentation of a solid rocket engine test stand. Work to be done at Edwards AFB, Muroc, Calif.

$1,353,244—**Goodyear Aircraft Corp.,** Akron, Ohio, for equipment and services to increase the Air Force's TM-76A *Mace* missile launch facilities in West Germany.

$1,133,806—**Melabs, Inc.,** Palo Alto, Calif., for work on mobile electronic reconnaissance equipment (supplemental contract).

$1,100,000—**Avco Corp.,** New York City, for work on re-entry vehicles (supplemental contract). Work to be done at Wilmington, Mass.

$1,100,000—**Rand Corp.,** Santa Monica, Calif., for research in aerospace sciences (supplemental contract).

ARMY

$16,306,171—**Hercules Powder Co.,** Wilmington, Del., for continued research and development on solid propellants.

$14,000,000—**Burrough Corp.,** Detroit, Mich., for classified work.

$1,952,100—**Esso Research and Engineering,** Linden, N.J., for research on solid propellants.

$1,632,231—**Ford Instrument Co., Div. of Sperry Rand Corp.,** Long Island City, N.Y., for classified work.

$1,282,900—**American Bosch Arma Corp., Tele-Dynamics Div.,** Philadelphia, for weapons control switching equipment.

$734,866—**Martin Co.'s Orlando Div.,** Orlando, Fla., for spare parts for modification kits for a communications link between the Birdie air defense system and the *Nike* missile batteries which it coordinates electronically.

$354,000—**Sylvania Electric Products, Inc.'s Sylvania Electronic Systems Div.,** Mountain View, Calif., for a study of methods to detect or prevent the placing of nuclear weapons in orbit and to restrict the flight testing of missiles.

NAVY

$20,776,540—**Westinghouse Electric Corp.,** Pittsburgh, for design, development, and furnishing of nuclear reactor components for nuclear-powered submarines.

$16,306,171—**Hercules Powder Co.,** Wilmington, Del., for continued research and development on solid propellants.

$10,000,000—**Beech Aircraft Corp.,** Wichita, for follow-on production of *KD2B-1* supersonic target missiles.

$10,000,000—**North American Aviation, Inc.,** Columbus, Ohio, for increased funding for the A-5C Vigilante weapon system.

$5,000,000—**General Telephone and Electronics Corp.,** Mountain View, Calif., for the design and production of special-purpose direction-finding equipment.

$4,244,612—**Ford Instrument Co., Div. of Sperry Rand Corp.,** Long Island City, N.Y., for fire control computers for *Terrier* and *Tartar* missiles.

$1,282,900—**Tele-Dynamics Div., American Bosch Arma Corp.,** Philadelphia, for weapons control switching equipment.

DOD

$1,000,000—**Filtron Co.,** Flushing, N.Y., for *Minuteman* missile installations equipment (two contracts).

NASA

$1,860,000—**Pratt & Whitney Aircraft Div., United Aircraft Corp.,** for development of a variable-thrust liquid-hydrogen rocket engine.

$660,000—**Vitro Services Div. of Vitro Corp. of America,** Eglin AFB, Fla., for operation of electronic data acquisition equipment at Marshall Spaceflight Center's Test Div., which performs "hot and cold" tests on *Saturn* space vehicles.

$107,000—**General Electric Co.'s Space Technology Center,** Valley Forge, Pa., for subsystems integration and test for the *Nimbus* weather satellite.

INDUSTRY

$2,000,000—**Bell Aerosystems Co.,** Buffalo, N.Y., from the **Boeing Co.,** for research and development work on the *X-20 Dyna-Soar* space glider.

$2,000,000—**Linde Co., Div. of Union Carbide Corp.,** New York City, from **Aerojet-General Corp.,** for supplying liquid nitrogen.

$1,112,672—**Martin Co.'s Orlando, Fla., Div.,** from **Electro-Mechanical Research, Inc.,** for manufacturing services for a telemetry system for NASA's Manned Space Flight Range.

$1,000,000—**Bendix Corp.'s Pacific Div.,** North Hollywood, Calif., from **Douglas Aircraft Co.,** for supplying hydraulic components for the *Nike-Hercules* ground-to-air missile system.

$650,000—**United Control Corp.,** Redmond, Wash., from **Lockheed Missiles and Space Co.,** for development and initial production of quantities of programming and sensing devices to be used in the *Polaris A-3* missile

Space Technology Laboratories, Redondo Beach, Calif., from **General Precision Inc.'s Aerospace Systems Div.,** for work on the guidance and control system of the Air Force's *Mobile Mid-Range Ballistic Missile* (*MMRBM*) (undisclosed amount).

Fairchild Stratos Corp., Bay Shore, N.Y., from **McDonnell Aircraft Corp.,** for design and manufacture of specialized ground refrigeration equipment for the *Gemini* spacecraft (undisclosed amount).

Hurletron, Inc., Wheaton Engineering Div., Wheaton, Ill., from **McDonnell Aircraft Corp.,** for precision timing and voltage-sensing devices (undisclosed amount).

International Telephone and Telegraph Corp.'s Industrial Products Div., San Fernando, Calif., from **General Dynamics/Pomona,** for design and development of two power supplies for the *Mauler* weapon system (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Supply Officer
U.S. Naval Research Laboratory
Washington 25, D.C.

Solar cell power supply panels for satellite space flight. An assembly of silicon cells of N/P construction with optical filters attached thereto, with assembly of cells into shingles, fitted on metal honeycomb panels. Approximately 11"-dia. physical size with electrical output of at least 405 MADC at 12.5 VDC under sunlight illumination. Acceptance measurements to be conducted at Table Mountain, Calif., and performed by the contractor—13 each. Solar cell power supply panels for satellite space flight. An assembly of silicon cells of N/N construction with optical filters attached thereto, with assembly of cells into shingles, fitted on metal honeycomb panels. Approximately 9"-dia. physical size with electrical output of at least 240 MADC at 12.5 VDC under sunlight illumination. Acceptance measurements to be conducted at Table Mountain, Calif., and performed by the contractor—13 each. Request for copies of this RFP 173/N81562/63 will be accepted and retained pending approval for purchase. It is anticipated that the request for proposal will not be forwarded for at least three weeks from date of synopsis.

Headquarters
2709th Air Force Vehicle Control Group
Memphis, Tenn.
Procurement and Production Div.

Hose assembly applicable semitrailer liquid oxygen-nitrogen missile recharger USAF type AM32R6; part numbers: Cambridge Corp. B11065 and Flexonics 354-035-5002—39 each. Destination—Mobile, Ala. Specifications, plans or drawings do not apply and are not available. Above identification is descriptive rather than restrictive. Offers of "or equal" item will be considered for award if item is clearly identified in proposal and determined by government to be equal to brand name in all material respects. RFP 40-604-63-515Q. RFP due date 2-19-63.

Directorate
Procurement and Production (SAPOS)
Kelly AFB, Tex.

1115-NC051783PCM (P/N 237R710G3) spacer—6 each. 1115-NC052386PCM (P/N 237R704G2) cover—6 each. Applicable to MK-6 Mod 3 *Titan II* re-entry vehicle. Furnish item identification data. No drawings of specs are available. Deliver Transportation Officer, Kelly AFB, Tex. RFP SA-3-157(Q). RFP due date 2-4-63. Items identified by General Electric Co., 3198 Chestnut Street, Philadelphia, Pa., part numbers. Direct inquiries to J. V. O'Reilly, WAlnut 3-5411, Ext. 67116, Kelly AFB, Tex.

Strontium-90 May Furnish Space Electrical Power

QUEHANNA, PA.—The radioisotope strontium-90 may furnish electrical power of 100 watts or more for space applications if a tough re-entry problem is either solved or considered unimportant from a political standpoint.

The trouble is that the Sr-90 fuel produced by the Martin Co. for an isotopic generator for a Coast Guard application is too tough to burn up during re-entry. International complications might result if this fuel landed on foreign territory.

Martin Co. officials are hopeful, nevertheless, they will be able to devise an Sr-90 fuel able to disintegrate during re-entry; or that the Atomic Energy Commission will consider the possible political hazard of the present fuel small enough to permit its testing in a spacecraft.

Power sources based on Sr-90—a beta emitter—are expected to be far less costly than a plutonium-fueled system such as SNAP-3—an alpha emitter—operating in *Transit IVA*. Some experts say the cost would be comparable to an installed solar-cell system.

The Sr-90 system, moreover, would have a relatively long life since the isotope has a half-life of 28 years.

The first Sr-90 processed by industry as a nuclear fuel was installed last week in an atomic generator—SNAP-7B—that will power an automatic lighthouse for the Coast Guard. The 60-watt generator was fueled with 225,000 curies of strontium titanate ($SrTiO_3$)—a safe form of Sr-90—at Martin Co.'s radioisotope production facility located in this mountainous region of north central Pennsylvania.

The strontium titanate processed at the Quehanna facility for SNAP-7B is part of one million curies that Martin will produce during the current fiscal year under a new AEC program to bank strontium fuel for future use in nuclear generators. The fuel processed here is made from strontium carbonate, a waste material resulting from fission in atomic reactors.

Promethium-147 may also be a highly useful radioisotope for space work, according to Martin scientists. Under study now, the material would ease the re-entry problem, is a beta-emitter, and has a half-life of 2.6 years. Its useful power density is as high as 2.2 watts/cc as compared with 1 watt/cc for Sr-90.

Pm-147, however, would have to be aged about a year and a half to rid it of gamma emissions. ⌗

– about the high cost of HELIUM

There is now a way to do something about it.

It is of particular interest to anyone using over 70,000 cu ft of recoverable He per year.

The HELIUM RE-PURIFIER offers economies which at first glance appear to be unbelievable. For example, the 190,000-cu-ft user of He can save himself up to 57.01% in gas cost.

And in that figure are included all phases of operation of the HELIUM RE-PURIFIER, depreciation, interest on investment, floor space cost, etc.

With such facts before him, the alert user of He might well say: "Yes, but what about purity? Our work is critical."

Answer: The HELIUM RE-PURIFIER scrubs used He to a purity exceeding 99.995% (less than 50 ppm total impurities).

To indicate why the HELIUM RE-PURIFIER is a practical thing there is a Table which compares costs and savings for users in various cu ft ranges. Again, all costs and operating expenses are included.

continued on Page 43

Circle No. 1 on Subscriber Service Card



Why S-A Tracking Antenna Pedestal Systems Offer THE BEST PRICE/PERFORMANCE RATIO

Versatility, MIL SPEC compatibility, reliability, state of the art manufacturing techniques, quick delivery, and full system capability, you get them all from Scientific-Atlanta.

VERSATILITY. For antennas up to 30 feet diameter, Scientific-Atlanta offers three basic pedestals with output torques from 500 to 10,000 ft.-lbs., velocities to 30°/sec, accelerations to 30°/sec², and accuracies to 0.08° static and ±0.05°/rpm. Multiple mode operation; automatic, slave, manual or pre-programmed tracking. A full range of optional extras and accessory equipment is available to meet virtually any operational requirement.

MIL SPEC COMPATIBILITY. Scientific-Atlanta pedestals are designed to operate under MIL SPEC environmental and RFI conditions.

RELIABILITY. Scientific-Atlanta pedestal systems use solid state servos, printed circuit dc motors for long life and quick response, large parallel mounting surfaces for adaptability plus rigidity of antenna mounting, fail-safe brakes, electrical and mechanical limit stops.

MANUFACTURING. Assembly of tracking pedestals from standardized modules allows Scientific-Atlanta to meet a wide variety of customer requirements and pass along the cost benefits of mass production.

QUICK DELIVERY. Most TPS units are available 6 to 8 weeks ARO.

SYSTEM CAPABILITY. Scientific-Atlanta offers its customers a unique and proven capability to provide complete telemetry tracking systems, special antenna systems, and servo-control systems.

FOR MORE INFORMATION, please address Scientific-Atlanta, Inc., P.O. Box 13654, Atlanta 24, Georgia, phone: (404) 938-2930.

SCIENTIFIC-ATLANTA, INC.

20

Circle No. 16 on Subscriber Service Card

Plug Nozzles Promising For Space Station Design

by Russell Hawkes

Los Angeles—Development of plug-nozzle rocket engines will make it possible to assemble ring-shaped space stations on the Earth and place them in low Earth orbits with a one-stage launch trajectory, General Electric Missile & Space Division reports.

A space station design based on a pair of studies conducted by the division for NASA was described at the American Astronautical Society meeting here by Bruce N. Heuffer, consulting engineer to GE. The torus shape of the station is made up of a number of intersecting spherical pressure vessels which are used as propellant tankage during the launch phase and as crew, equipment, and supply spaces after the orbit is established. The concept promises the smallest launch energy requirement of any of the methods proposed for orbiting toroidal stations.

The design has distinct advantages for both phases of the mission. Research has shown that a pressurized torus made up of spherical segments weighs only 78% as much as a plain torus, and a sphere is a good shape on which to mount a plug nozzle. The plug-nozzle engine makes it possible for the station to be its own launch system, because its effective nozzle area ratio is aerodynamically adaptive to ambient pressure. Thus, it can provide an efficient nozzle from sea level to the vacuum of space.

Before the plug nozzle investigation for NASA, GE engineers had calculated that two stages would be required for the job. The orbit altitude picked for the single-stage space station is 200 n.mi.; it cannot reach synchronous-orbit altitude of 22,000 mi., where a number of useful missions could be found for it. Several ways of shifting to a higher orbit have ben suggested, but none has been thoroughly studied.

The GE staff approached the idea of launching a completed toroidal space station with a strong suspicion that performance losses due to drag during the booster phase of flight might be completely unacceptable. It was feared that at transonic speeds flow through the center of the torus would choke, producing a sharp rise in the flat plate area of the system. However, machine-computed trajectories based on the estimated drag vs. Mach no. curve for the torus proved to be similar to those for a more conventional shape. Maximum

drag coefficients for the two shapes are nearly the same, and trajectories appear to be more sensitive to this factor than to the shape of the curve. Neuffer said he is confident these results would be borne out by experimentation.

• **Room to spare**—Each spherical segment of the proposed space station has a plug-nozzle engine burning liquid hydrogen and liquid oxygen. These propellants were chosen not only for their high specific impulse, but because they are non-toxic and do not require decontamination of the tanks before the space station crew moves in. Also, residual propellants can be burned to manufacture water for the crew and excess oxygen can be combined with nitrogen from the tank pressurization system to make air. The large volume required by hydrogen results in roomier space station compartments.

The crew is to have a shirt-sleeve environment with a sea level atmosphere and a l-g radial acceleration. For a 200-ft.-dia. station, 6 RPM rotation gives l-g. The crew, supplies, and equipment can be ferried to the station by conventional vehicles. The thickness of the aluminum alloy wall is assumed to be 0.4 in., which will be adequate to contain a relatively high cabin pressure, permit feeding of propellants, and supply considerable shielding against radiation and micrometeoroids. A thickness of 1 cm of aluminum is considered adequate shield against all except very intense solar flare radiation.

The thickness needed to protect against micrometeoroid strikes cannot be determined exactly because of the lack of agreement on the size distribution of micrometeoroids.

The plug-nozzle engine suggested by GE consists of 720 small combustion chambers arranged in four concentric rings around the conical plug. Advantages of the multiple chamber design include ease, speed, low cost, and low risk of failure in the development of the chamber and injector designs. Since propellants would be pressure-fed, chamber pressure would be low. Initial tank pressure would be about 200 psia, and would decrease according to a planned schedule as propellants are consumed. Therefore, propellant flow rate and thrust would follow a corresponding schedule of reduction. At 261 sec. after lift-off, thrust would be decreased even further by shutting down the outer rows of combustion chambers to get the optimum effective nozzle area ratio for space operation.

The hypothesized GE space station would weigh 10.9 million lbs. at launch and 741,000 lbs. in orbit. Total initial thrust for a 16-segment torus would be 12 million lbs., or 750,000 lbs. per engine. ⌗

— about the high cost of HELIUM

continued from Page 41

The Table showing relative costs and savings for users of the HELIUM RE-PURIFIER is self-explanatory.

Annual He Use Rate (cu ft)	Cost of New He ($0.09/cu ft)	Operating Cost of Re-Purifier (Dollars)	Annual Savings (Dollars)
400,000	36,000	10,600	25,400
350,000	31,500	9,415	22,085
300,000	27,000	8,770	18,230
250,000	22,500	8,225	14,275
200,000	18,000	7,480	10,520
190,000	17,100	7,351	9,749
180,000	16,200	7,222	8,978
170,000	15,300	7,093	8,207
160,000	14,400	6,964	7,436
150,000	13,500	6,835	6,665
140,000	12,600	6,706	5,894
130,000	11,700	6,577	5,123
120,000	10,800	6,448	4,352
110,000	9,900	6,319	3,581
100,000	9,000	6,190	2,810
90,000	8,100	6,061	2,039
80,000	7,200	5,932	1,268
70,000	6,300	5,803	497
60,000	5,400	5,674	—
50,000	4,500	5,545	—

One HELIUM RE-PURIFIER handles 650,000 cu ft per year, assuming a 5-day workweek of 8-hour days. Multiple-shift operation increases capacity to 1,950,000 cu ft per year. Additional units can be added as needed. Performance data based upon operation of 40 units currently installed throughout the world.

To meet the needs of those who want specific figures for their own operations, there is a "Helium Cost Analysis" sheet which will enable anyone to figure his own exact savings in He and money. The actual figuring, using your own facts, takes about 15 minutes.

continued on Page 45

Circle No. 2 on Subscriber Service Card

Why selecting a scientific or engineering computer without a feasibility study can be a costly error

And the one sure way to find the computer that suits you best

A scientific or engineering computer is a sizeable investment. Selecting one calls for a responsible decision. Far from being alike, computers vary in efficiency and in ways they can be used. They vary, too, in price—and the equipment price tag doesn't always reflect **true cost.**

Your selection, then, should be based upon a careful study. Concentrate not on details, but on finding the one computer that will best suit your firm's particular needs. You may find your answer in the Recomp® line of solid-state computers, as so many companies have. But two important considerations—**total** problem-solving time and **total** cost—best measure a computer's worth.

Which is the fastest computer?

The criterion to use is total problem-solving time. On the average, computing time represents only about 10% of the time required for complete solution of an engineering or scientific problem. Microseconds saved in computing mean nothing if hours are lost in programming, which often is 90% of the total job.

The Recomp line of small and medium-scale computers save programming **hours,** not just computing **microseconds.** They are simple to program, easy to operate, and have exceptionally large memories.

Which is the cheapest computer?

Scientific problem-solving computers sell from $40,000 and up; rent from $1,000 a month, and up. But in comparing price, remember: 1) Cost figures should cover the **entire working system** needed to accomplish a job. 2) "Man hours" saved are an important facet of cost. A company which once got 2 proposals a year from a top creative scientist increased this to 3½ with a computer (not Recomp). With Recomp, the company now gets 9 proposals per man a year.

Recomp offers a broad price range. The Recomp III, ideal for small-scale needs, can be leased for $1,495 per month, complete. For medium-scale needs, Recomp II can be leased beginning at $2,495. A complete line of peripheral equipment is available for both.

Will special personnel be needed?

Some computers are so complicated that engineers must spend months in learning how to use them. Others require the hiring of trained programming personnel. Both types, therefore, are more expensive than they might appear. Worse, the necessity of a programmer doubles the communication time between scientist and machine, thereby off-setting the value of the computer as a quick problem-solving device.

Recomp computers are among the easiest of all to operate and program. Engineers with less than eight hours instruction have had no problem using them profitably.

The one sure way to select a computer

The computer requirements of your company are unique. Only by conducting a feasibility study can you be sure of which computer suits you best.

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—names in the news—

Jack L. Bromberg: Named vice president-programs for the Missile and Space Systems Div. of the Douglas Aircraft Co., Santa Monica, Calif.

Edwin H. Rees: Appointed assistant director of administrative operations at TRW's Space Technology Laboratories, Redondo Beach, Calif.

Herbert S. Evander: Named manager of marketing for Hughes Aircraft Co.'s semiconductor division, Newport Beach, Calif.

Frank Compton: Named vice president of advanced programs development at North American Aviation's Space and Information Systems Div., Downey, Calif. **George Jeffs** named vice president and paraglider program manager. **Dr. W. R. Laidlaw** named vice president of advanced system.

Michael J. James: Appointed sales manager, semiconductor products, for the Lansdale Div. of Philco Corp., Lansdale, Pa.

Andrew C. Hilton: Appointed director of personnel and organization at Fairbanks Whitney Corp., New York City.

John M. Ward: Elected vice president of Haveg Corp., Wilmington, Del.

Herman A. Affel, Jr.: Appointed director of the Systems Sciences Div. of the Auerbach Corp., Philadelphia. **Arnold B. Shafritz** appointed associate director.

Paul S. Mirabito: Appointed corporate vice president-administrative programming of the Burroughs Corp., Detroit. Mich.

Austin Stevens: Formerly manager of public relations of the Martin Co.'s Washington office, appointed assistant director of public relations of the Aerospace Industries Assn., Washington, D.C.

James R. McNitt: Appointed group executive international communications operation-Latin America for International Telephone and Telegraph Corp., New York City.

Dr. Thomas B. Weber: Appointed manager, bioastronautics, Space Engineering Group, Beckman Instruments, Inc., Fullerton, Calif.

Albert P. Royle: Appointed advertising manager of Constantine Engineering Laboratories Co.'s Mahwah, N.J., division.

Alan G. Grey: Appointed manager of the International Div. of Kaiser Steel Corp., Oakland, Calif.

Dr. Wendell B. Sell: Appointed to the newly created post of executive vice president, Packard Bell Electronics, Los Angeles.

J. Reed Stovall, Jr.: Appointed manager of market development of International Resistance Co., Philadelphia.

George F. Anisman: Appointed marketing director for Security Valve Co., a division of Menasco Manufacturing Co., South Pasadena, Calif.

Charles J. Gallant: Will relinquish his position as executive vice president and director of North American Aviation, Inc., El Segundo, Calif., and effective Feb. 21, assume new duties as special assistant to the president.

Robert G. Dee: Appointed manager, product and market planning, Radio Corp. of America's Electronic Data Processing Div., New York City.

Robert J. Dobuski: Promoted to vice president and general manager of Vulcanized Rubber & Plastics Co., Morrisville, Pa.

Peter G. Fielding: Promoted to research director-aeronautics and transportation at Booz, Allen Applied Research, Inc., Washington, D.C. **Charles E. Lathey** promoted to research director-electronics and communications.

Dr. Vincent M. Jolivet: Associate professor of finance at the University of Washington Business School, elected to the board of directors of Rocket Research Corp., Seattle, Wash.

T. R. Erixon: Named manager of the service engineering operations for the central and midwest regions of General Electric's Defense Programs Operation, Dayton, Ohio.

Robert W. Jagoe: Named manager of the newly established Infrared/Optics/Laser Group of Sperry Rand Corp., Great Neck, N.Y.

Edward Jenks: Appointed manager of the Electro Products Div. of Western Gear Corp., Pasadena, Calif.

Robert M. Daiss: Elected president of H. I. Thompson Fiber Glass Co., Gardena, Calif. **Paul W. Byall** elected executive vice president and **Leon Parker** promoted to senior vice president.

Robert A. Dietrich: Appointed director of the Research Center of General Precision's newly formed Industrial Products Group, Glendale, Calif.

Dr. Karl Folkers: Elected president of Stanford Research Institute, Menlo Park, Calif.

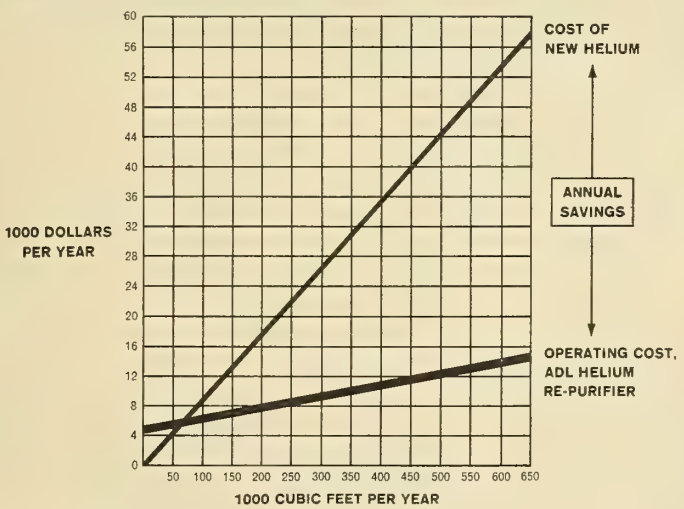
John R. King: Appointed executive vice president and treasurer of Rimak Electronics, Inc., North Hollywood, Calif.

H. M. Conner: Appointed to the new post of assistant to the president of Fairchild Stratos, Hagerstown, Md., and will manage the Washington, D.C. office.

– about the high cost of HELIUM

continued from Page 43

Here is a chart showing the He and cash savings attained at various levels of use rate.



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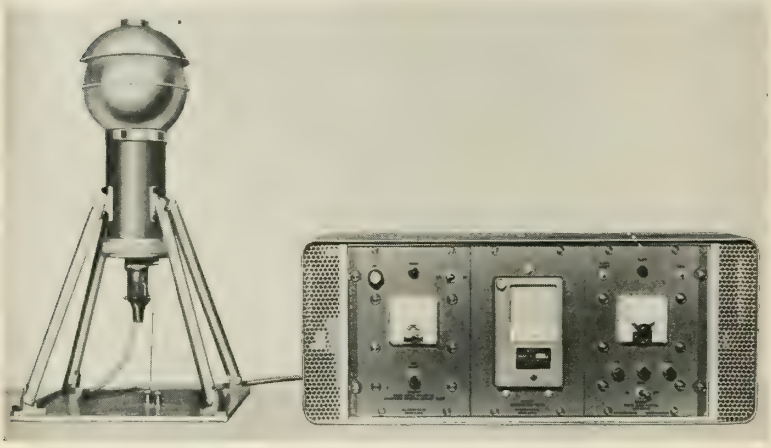
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Circle No. 3 on Subscriber Service Card

New Product of the Week:
Lightning Warning System



A system to measure, monitor and record atmospheric conditions capable of producing lightning has been developed by B. K. Sweeney Mfg. Co. Model SWE-1196 is designed for use in fueling, munition storage, and missile launch areas, etc., to alarm before atmospheric conditions can produce lightning. The system operates on the principle of measuring an electrostatic voltage across a special component by low-resistance coupling to the atmosphere with a radioactive alpha emitter. An insulated spherical-shaped probe assumes the potential of the atmosphere surrounding it.

Circle No. 225 on Subscriber Service Card

Miniature Shunts

Miniature shunts, which operate at high density over a wide temperature range, are being marketed by Angstrohm Precision Inc. The units operate with standard voltage precisions of 0.1% throughout the operating temperature range. Other typical specifications include current up to 36 amps, and a temperature range from 0° to 65°C as standard, with other ranges available on special order.

Circle No. 226 on Subscriber Service Card

Glass Fiber Sleeving

An improved Class H silicone varnish glass fiber sleeving is being marketed by Bentley-Harris Mfg. Co. The BEN-HAR 1062, features a degree of flexibility never before seen in varnished sleeving. Due to a unique manufacturing process, the film coating is more uniform than heretofore available, has better resistance to mechanical damage and can be produced in continuous lengths through 1-in I.D. Superior flexibility is maintained at Class H ambient temperatures and the low-temperature brittle point is below −73°C. The sleeving is fungus inert and resistant to inorganic acids, alkalis, and aliphatic hydrocarbons. Other properties are: self-extinguishing; dissipation factor 0.10 max.; insulation resistance 10^6 megohms; dielectric constant 3.0 maximum. It is rated for continuous operation at 200°C and is produced in the regular NEMA and military grades.

Circle No. 227 on Subscriber Service Card

RMS Audio Voltmeter

Available from B & K Instruments, Inc. the Model 2410 RMS audio voltmeter is a universal instrument, designed for measurement in the audio frequency range. The RMS rectifier circuit provides accurate true RMS measurement of signals with crest factors up to three within an accuracy better than ±0.5 db.



The Model 2510 is for use whenever audio-frequency voltages are measured, within the range of a few millivolts to 1000v. The unit can also be used as a calibrated A.F. amplifier. Voltage is available at the output terminal and amount of amplification employed is indicated by input-switch position. Amplification is variable in 10-db steps, maximum is 60 db. Measurement of A.F. currents is accomplished by connecting an external shunt resistor across the input terminal. Voltmeter sensitivity is easily and accurately checked by a built-in reference voltage, developed across a zener diode.

Circle No. 228 on Subscriber Service Card

Two-Phase Inverter

A miniaturized, two-phase power inverter, featuring a unique overload shut-off switch with automatic recovery, has been developed by Giannini Controls Corp.

The solid-state inverter actually cools during shut-off caused by overload, a condition which can be sustained for an indefinite period. Reaction time to overload is less than 10 microseconds and recovery time is less than 100 milliseconds.

Potential applications include use in servo systems, and powering precision speed rotary equipment, such as commutators, gyro motors and tape and film transports.

Circle No. 229 on Subscriber Service Card

Power Supply

General Technology Corp. has available Model 310-B Standby Power Supply. This unit offers automatic standby power for their Model 304-B Rubidium Frequency Standard and guarantees continued operation of the Frequency Standard should normal power sources fail. An internal battery type supply with a rated capacity of 10 ampere hours, the Model 310-B is equally suitable as a standby power source for other systems requiring continuous operation.

The vented nickel-cadmium battery is automatically recharged after power failure. External batteries may be added in parallel with the internal battery for greater capacity. Full overload protection is provided and the charging supply is electronically current limited.

Circle No. 230 on Subscriber Service Card

HERE IS A PARTIAL LISTING OF CONTENTS

UNITED STATES GOVERNMENT:
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

INDUSTRIAL SECTION:
Detailed listings of major missiles/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

COMPANY REPRESENTATIVES SECTION:
Listing company representatives stationed in Washington and in most strategic missile/space areas.

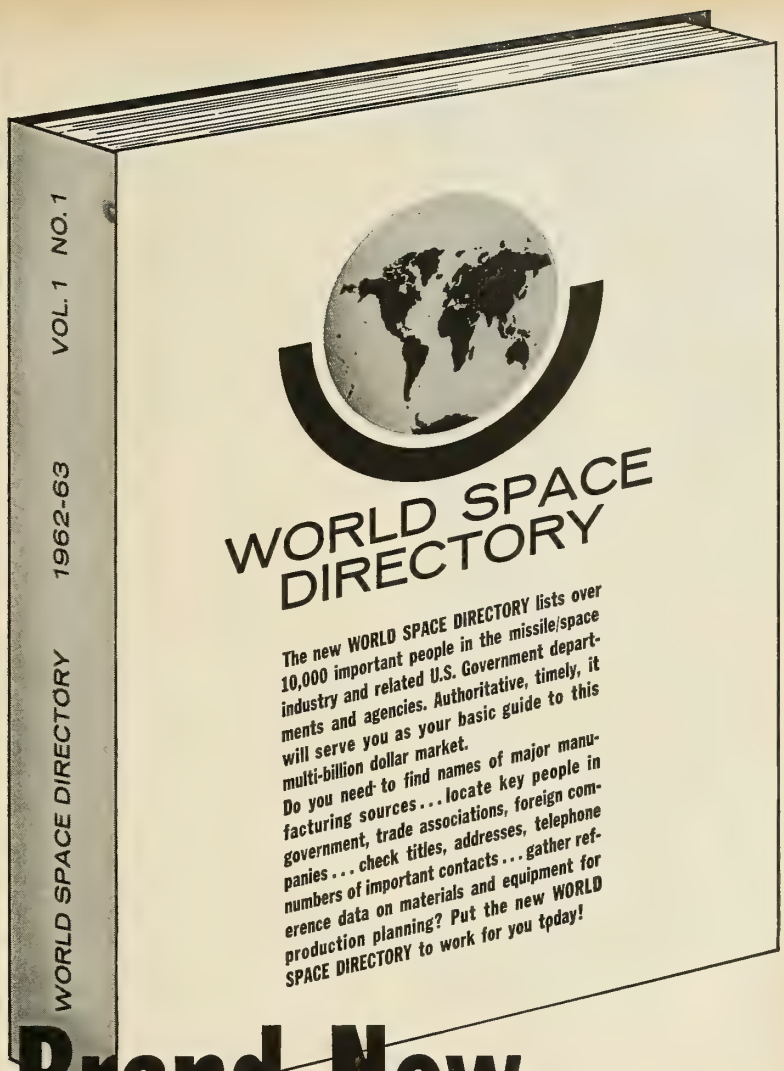
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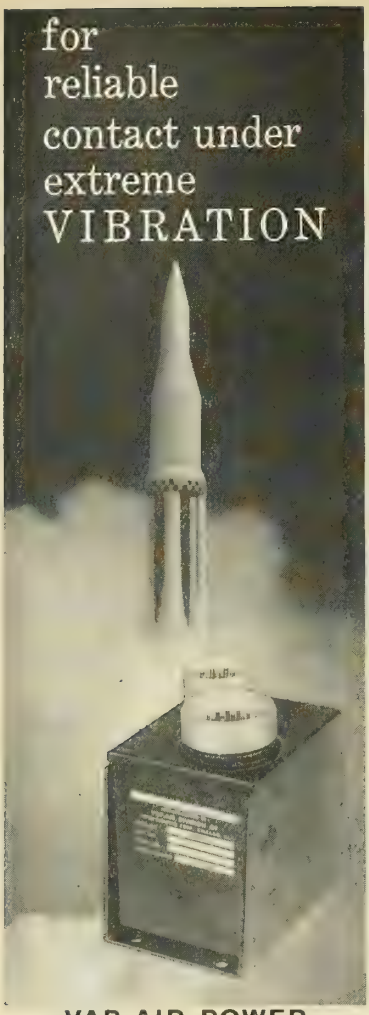
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Circle No. 17 on Subscriber Service Card

Proximity Switches

Two time-delay proximity switch systems have been developed by Minneapolis-Honeywell's Micro Switch Div. The systems are especially valuable to show when an object has been at a specified position for a certain length of time, or to indicate when production lines have slowed or stopped, or when parts jam.

Both systems respond to ferromagnetic material within the detection range of the sensor without physical contact. Each system is available with three amplifier models that overlap the time delay from 0.1 to 30 sec. Amplifiers have integral time delay and sensitivity adjustment.

Circle No. 231 on Subscriber Service Card

Portable Infrared Pyrometer

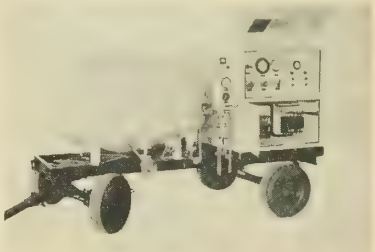
A portable infrared radiation pyrometer Model PY 15, completely self-powered unit, is being marketed by Pyrotel Corp. The instrument is the first truly postable means of accurately measuring temperatures from a distance (or as close as 18 in.) by picking up incoming infrared radiation from hot objects which are impossible or undesirable of physical contact through ordinary means of temperature measurement.

Circle No. 232 on Subscriber Service Card

Cryogenic Gas Converter

A Cryogenic gas-conversion system suitable for runway servicing of aircraft and airborne missiles has been developed by The Cosmodyne Corp.

As a substitute for gas cylinders and compression systems, its 150-gal. liquid gas capacity is equivalent to more than 130 standard gas cylinders at a use pressure of 1000 psi. The RA-4 is capable of pressures up to 10,000 psi and flows of up to 18,400 standard cu. ft. of contaminant-free gas per hour. The



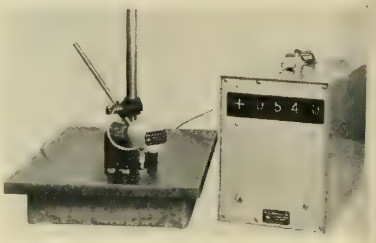
conversion system includes a cryogenic, vacuum-insulated tank, high-pressure cryogenic pump and vaporizer. Also included are vacuum, pressure, and temperature gauges, as well as relief and safety devices.

Circle No. 233 on Subscriber Service Card

Electronic Gage

Wang Laboratories is marketing a precision electronic gage which can be used in production operations to make measurements in increments of 0.0001-in. or smaller.

The pick-up is a conventional dial



indicator to which is attached the necessary detecting circuitry. The electronic information is then transmitted to the indicator and direct digital display of numbers is obtained.

In actual operation, this can start from any fixed reference point and measurements can be made in either direction in the increments desired. Readings are instantaneous so that this equipment is an ideal tool for quality control, inspection, and production of precisely machined products.

Circle No. 234 on Subscriber Service Card

Encoder/Decoder

A five-channel resonant-reed relay, designed for electronic remote control by audio frequency tones, is available from Bramco, Inc. Designated the RD-5, the resonant reed relay is sensitive to five predetermined frequencies ranging from 100 to 1000 cps. Selectivity, beyond the five basic channels, can be expanded by using sequential or simultaneous tones.

The RD-5's decoding resonant reeds, which can be used for multiple function control over an RF or copper loop, have relay contacts that close intermittently when the predetermined frequency is transmitted. Secondary relays, or amplifiers, then complete the control circuit.

Circle No. 235 on Subscriber Service Card

Pulse-Type Ultrasonic Tool

A self-powered pulse-type ultrasonic inspection instrument with CRT display is available from Krautkramer Ultrasonics, Inc. It employs all contact-testing pulse techniques for high-precision flaw detection and thickness measurements. Send/receive probes give accurate measurements of thickness on corroded surfaces, and it is said to have excellent resolution close to the surface.

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—when and where—

JANUARY

31st Annual Meeting, American Meteorological Society, New York City, Jan. 21-24.

Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

11th Annual Physics Show, Statler Hilton Hotel, New York City, Jan. 23-26.

Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn., International Inn, Washington, D.C., Jan. 28.

12th Annual Quality Control Clinic, Minnesota Section, ASQC, Leamington Hotel, Minneapolis, Minn., Jan. 29.

Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

1963 Winter Convention on Military Electronics, IRE PG MIL, Ambassador Hotel and IAS Bldg., Los Angeles, Jan. 30-Feb. 1.

FEBRUARY

Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Feb. 5-6.

Electronic Sales-Marketing Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques, UNESCO Bldg., Paris, Feb. 11-15.

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Paris, France—11 Rue Condorcet; TRU 15-39

Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory, Engineers Club, Dayton, Ohio, Feb. 12-13.

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Colo., Feb. 18-19.

Conference on Crew Escape Techniques for Aerospace Vehicles, sponsored by Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Feb. 19-20. (Secret)

Fourth Annual Reliability Symposium, Los Angeles Section, ASQC, Statler Hilton Hotel, Los Angeles, Calif., Feb. 20.

1963 International Solid State Circuits Conference, sponsored by IRE, AIEE, and University of Pennsylvania, Philadelphia, Feb. 20-22.

Quality Control Conference, Western Region, ASQC, Flamingo Hotel, Las Vegas, Nev., Feb. 21-22.

Society for Nondestructive Testing and Southwest Research Institute Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, Granada Hotel, San Antonio, Tex., Feb. 26-28.

American Physical Society Meeting, Rice University, Houston, Tex., Feb. 28-Mar. 2.

MARCH

American Society for Quality Control Annual Seminar, Engineers Club, Dayton, Ohio, Mar. 2.

American Society of Mechanical Engineers, Aviation and Space, Hydraulic, and Gas Turbine Conference and Products Show, Statler Hilton Hotel, Los Angeles, Mar. 3-7.

1963 Microminiaturization Congress, Sheraton Hotel, Philadelphia, Mar. 5-7.

Institute of the Aerospace Sciences National Propulsion Meeting, Pick-Carter Hotel, Cleveland, Mar. 7-8.

American Society for Quality Control Annual Quality Control Forum, King Edward Sheraton Hotel, Toronto, Can., Mar. 9.

American Institute of Chemical Engineers National Meeting, Roosevelt Hotel, New Orleans, La., Mar. 10-14.

American Rocket Society Electric Propulsion Conference, Colorado Springs, Colo., Mar. 11-13.

Instrument Society of America National Conference on Instrumentation for the Iron and Steel Industry, Pick-Roosevelt Hotel, Pittsburgh, Pa., Mar. 13-14.

American Institute of Electrical Engineers Pacific Computer Meeting, California Institute of Technology, Pasadena, Calif., Mar. 15-16.

American Rocket Society and the Institute of the Aerospace Sciences Space Flight Testing Conference, Cocoa Beach, Fla., Mar. 18-20.

American Society for Metals Western Metal Exposition and Congress, Pan Pacific Auditorium, Los Angeles, Mar. 18-20.

Austerity at the $18-Billion Level

IN THE LIGHT of a booming missile/space budget of more than $18 billion for Fiscal 1964, it may seem strange to talk of an austerity budget for this field. But that is exactly what NASA Administrator James Webb considers it. High Air Force officials hold the same belief.

Both the fire and the financial philosophy with which the Administration set out to conquer space are sadly lacking. President Kennedy in 1961 pledged an all-out effort to beat the Russians to the Moon.

This is a race in which to be second is to be last.

Yet the Administration has drawn a line just short of the goal. We are to expend more than $5.7 billion on our space effort but we are to balk at spending the final $500 million which would move the lunar program forward at the fastest possible speed.

This is false economy at its worst.

No less an authority than the President's own appointee as Administrator of the National Aeronautics and Space Administration has made this quite clear in commenting on the FY '64 budget.

NASA prepared four budgets for submission to the Bureau of the Budget, at levels of $5.2 billion, $5.6 billion, $6.2 billion and $6.6 billion.

Mr. Webb is plain-spoken on the fact that the $6.2-billion budget would have provided for a faster pace on the lunar program.

"Yes, we could have speeded it up," he comments. "I say that categorically."

Other NASA sources set the time-saving at six months. This means the U.S. is pouring $5.7 billion into a national space program and yet sacrificing six months in the lunar race to affect a $500-million economy.

We fail to see the wisdom of this saving.

Congress is expected to be much more critical this year of the growing NASA budget than it has been in previous years. But if Congress does its duty fully, it will devote more attention to the question of why this $500 million is to be withheld than it does to the overall size of the budget.

If reprograming of NASA funds is necessary to provide that $500 million, then Congress should be prepared to insist that other NASA programs be cut back to finance it. A new Electronics Research Center for NASA is undoubtedly needed. But is it needed more vitally than a victory over the Soviets by Project *Apollo?* That question should be asked of every NASA program which comes under Congressional scrutiny. We believe the budget sessions on the Hill could more profitably be devoted to this subject of reprogramming than to wielding an axe on the NASA budget.

Considering the importance which the President previously attached to the lunar effort, his support of it in his State of the Union address and in his budget message only can be described as lukewarm. If we are to defeat the Russians in the lunar race, the high priority necessary for Project *Apollo* must be made clear to the Congress and to the people.

This is all that President Kennedy had to say about the lunar program in his budget message:

"Efforts are being concentrated on the continued development of the complex *Apollo* spacecraft and the large *Advanced Saturn* launch vehicle needed to boost the *Apollo* to the Moon. A lunar orbit-rendezvous approach will be used to accomplish during this decade the first manned lunar landing. Under this technique the *Apollo* spacecraft will be boosted directly into orbit around the Moon, where a small manned lunar excursion module will be detatched and descend to the surface of the Moon. It will later return to the orbiting *Apollo* which will return to the Earth."

Where is the fervor with which the President previously backed this program? If it is not revived, the space budget may have a difficult path on the Hill.

THE NEGLECT of the military space budget can only be described as criminal. Increase of that budget from a level near $1.5 billion to something over $1.6 billion is niggardly.

When it is considered that the figures for military astronautics include funding of the operational *SAMOS* and *MIDAS* satellite systems, the amount to be devoted to each of the other military space programs shrinks to a level comparable to that to be devoted to the fertilizer program of the Tennessee Valley Authority.

There are no funds in the Fiscal '64 budget for procurement of *Gemini* capsules by the Air Force. Thus, the role the military will play in this vital program still remains up in the air.

It is true that the Air Force will participate in *Gemini* through the liaison office under Gen. Ritland and through supply of *Titan II* and *Atlas-Agena* vehicles. It is true that Administrator Webb and Secretary of Defense McNamara have jointly considered the military-NASA space budgets. But all of this falls far short of the effort which should be put into a military space program.

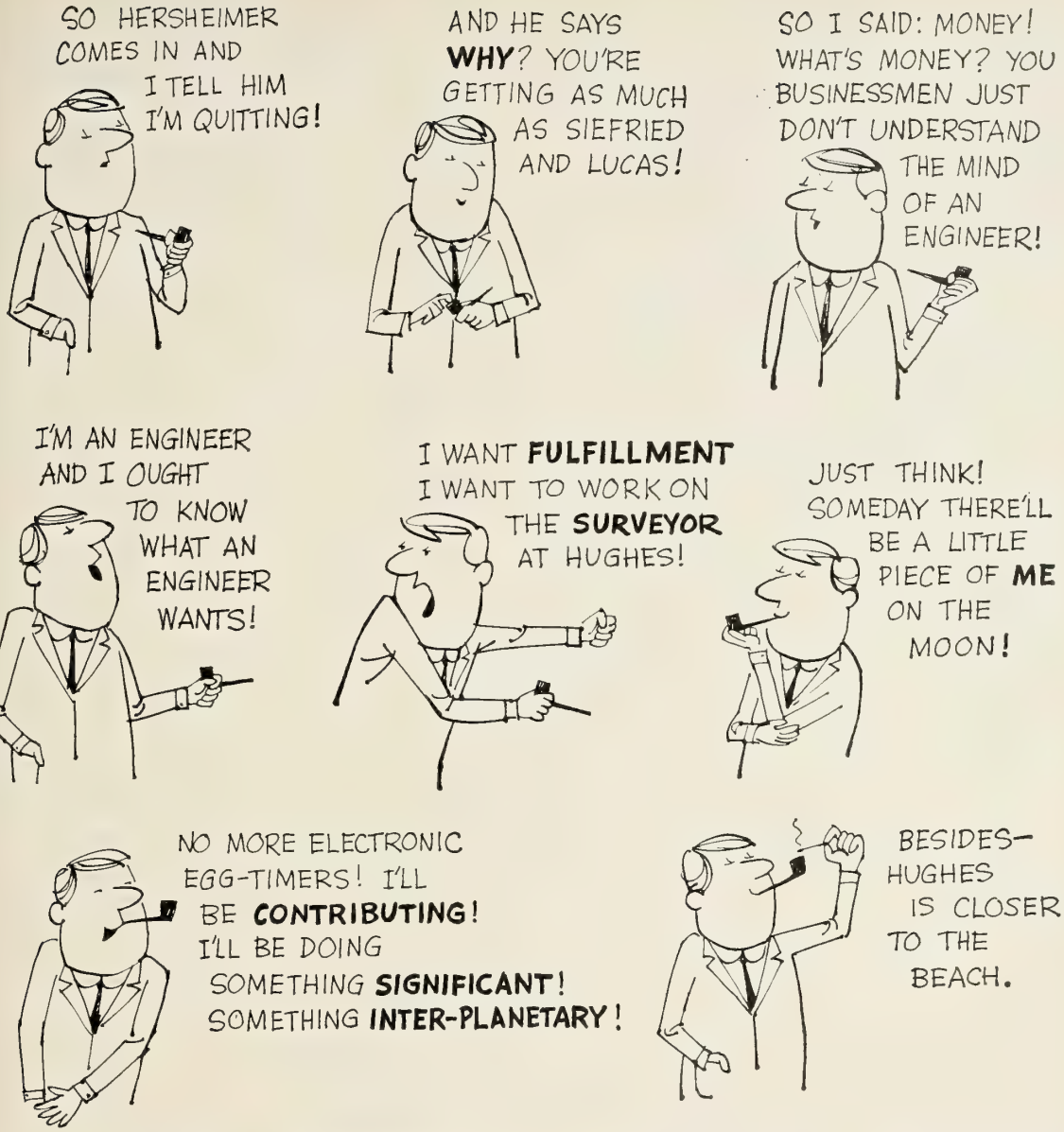
We hope that the high Air Force officers called to the Hill to testify on the budget make clear their dissatisfaction with neglect of the vital military space area. We hope that Congress takes strong action in this respect.

Refusal of top DOD officials to even comment on the military space program in their budget briefings indicates a head-in-the-sand attitude that is endangering the nation's military security.

To the officers of the Air Force now falls the responsibility of making this evident to Congress and to the nation. It is a far more important task than that of defending the lost causes of *Skybolt* or B-70.

It will be difficult for NASA and AF officials to explain the austerity of a budget which is devoting $18 billion to missiles and space. But it must be done.

William J. Coughlin



Hughes is hiring! Numerous opportunities now exist in a variety of advanced projects and studies. Examples include: The MMRBM—Mobile Mid-Range Ballistic Missile (Integration, Assembly & Checkout), TFX(N) Electronics, SURVEYOR—soft-landing lunar spacecraft, SYNCOM—synchronous-orbit communications satellite, VATE—automatic test equipment, BAMBI—anti-missile defense, and others. Positions are open at all levels for specialists with degrees from accredited universities.

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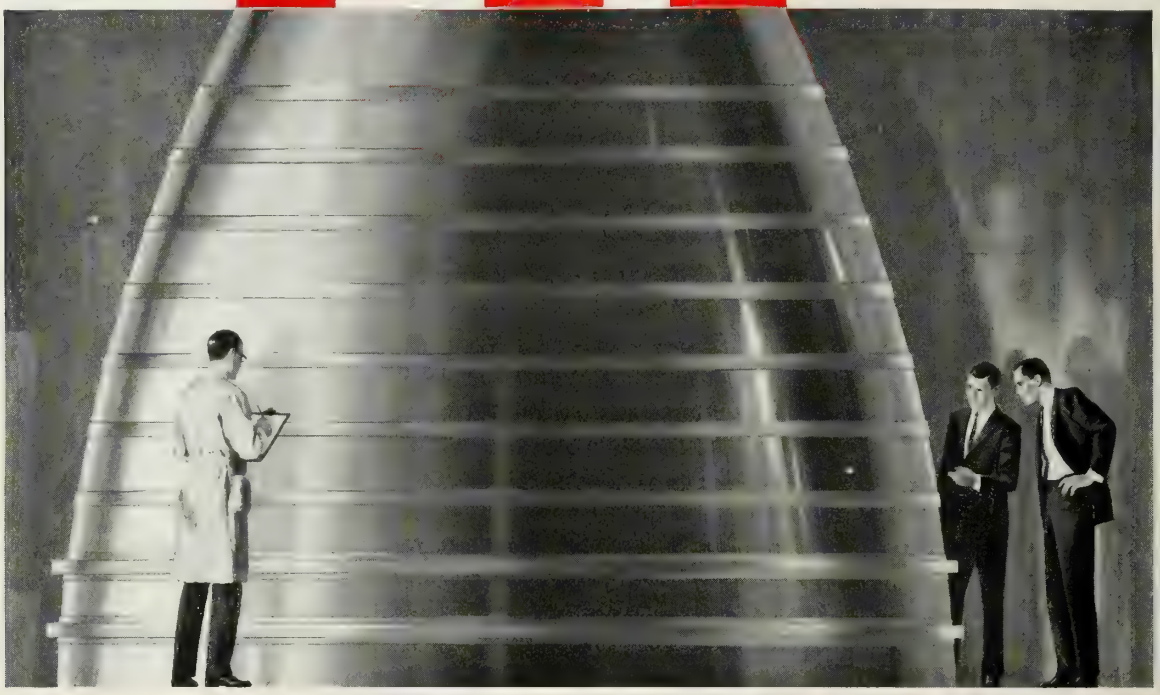
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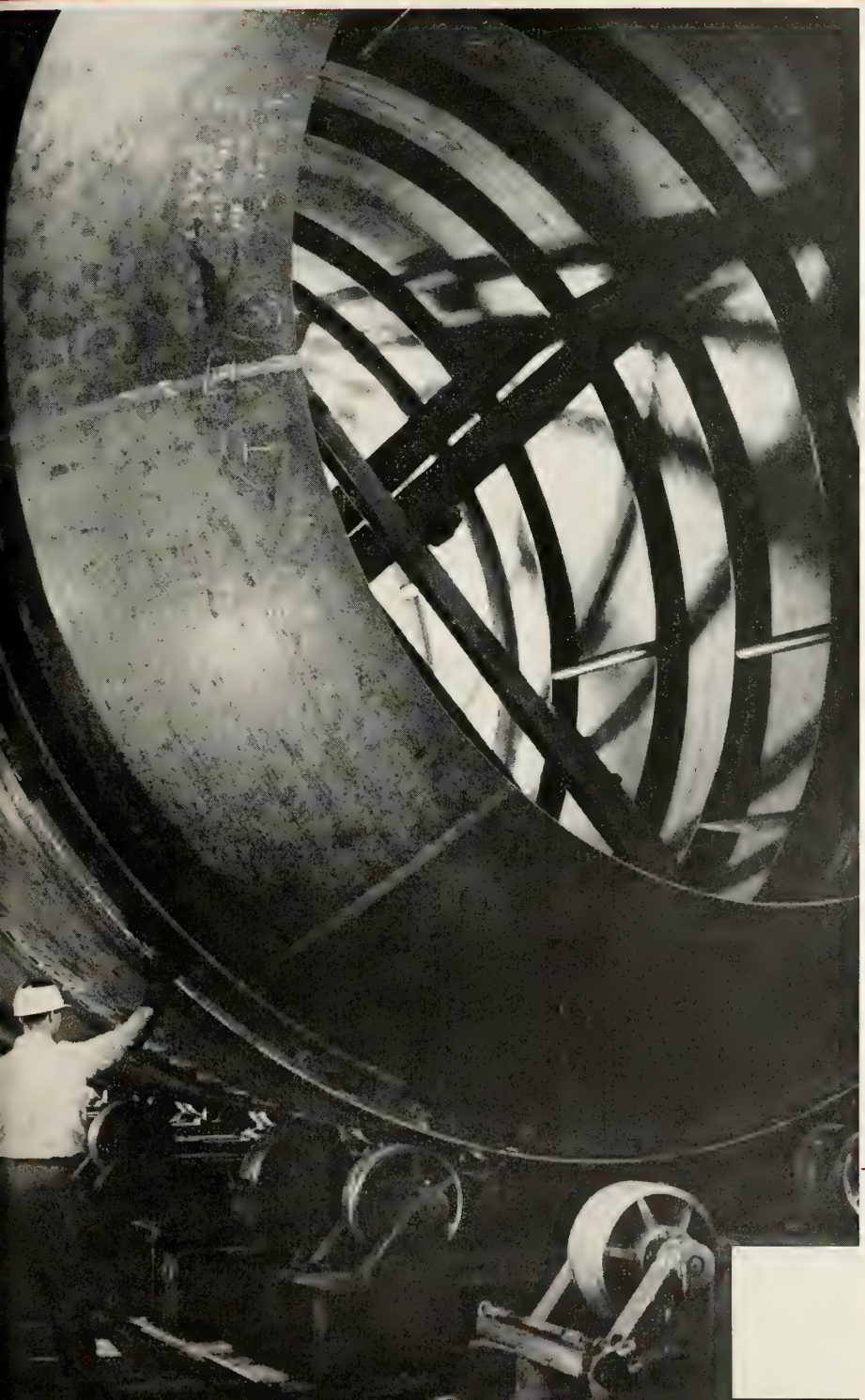
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missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

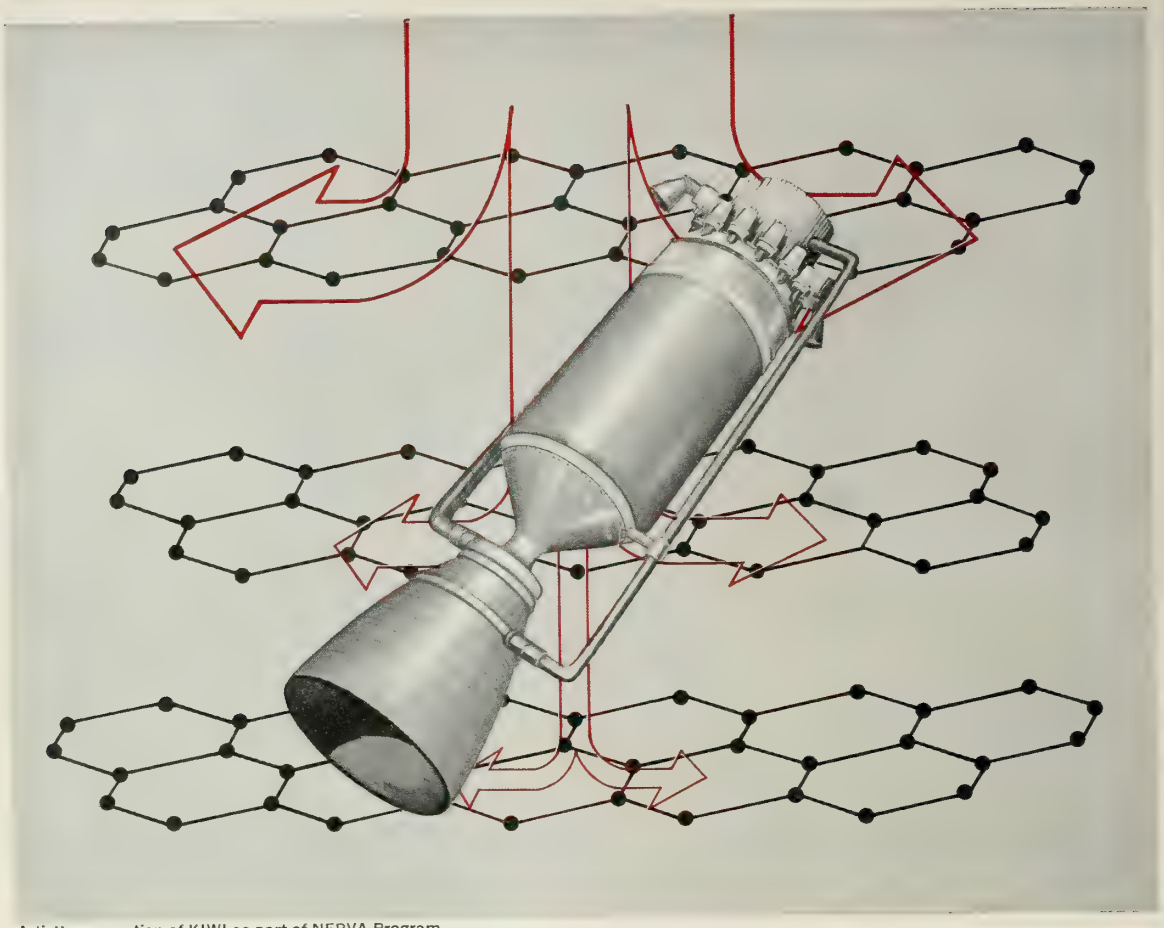


JAN 1963
HOUSTON

DOD-NASA Gemini Pact Threatens Dyna-Soar

- MIDAS Reverts To Study Phase
- New Life In Nike Program
- Emerson Swells Re-entry Art

Aerojet 280-in. Motor Case



Artist's conception of KIWI as part of NERVA Program.

BERYLCO PYROLYTIC GRAPHITE INSULATES KIWI

Like the bird for which it is named, the KIWI Experimental Nuclear Rocket is not designed to fly. But it does represent the key to sustained thrust necessary for the exploration of distant space. Insulating this prototype of future rocket engines is pyrolytic graphite—the space material characterized by unusual anisotropic thermal properties.

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PROPERTIES OF PYROLYTIC GRAPHITE

Density, lb/in³	0.079
Specific Gravity	2.20
Sublimation Temp.	6600°F
Emissivity at 2000°F.	0.83

Thermal Cond., BTU/hr., ft., °F

Temp.	"A" Axis	"C" Axis
70°	215	2.08
500°	205	0.89
1000°	170	0.80
2000°	100	0.67
3000°	80	0.80
4000°	60	1.0
5000°	50	1.3

Specific Heat, BTU/lb., °F

500°F	0.30	—
1000°	0.38	—
2000°	0.45	—
3000°	0.53	—
4000°	0.55	—
5000°	0.56	—

Linear Expansion, in/in x 10-3

Temp.	"A" Axis	"C" Axis
70—500°F	0.1	6.7
1000°	0.25	13.4
2000°	1.10	26.8
3000°	2.00	40.0
4000°	3.55	61.0
5000°	6.00	67.0

Ultimate Tensile Strength, ksi

70°F	14.0	1
500°	14.7	1
1000°	15.5	1
2000°	17.0	1
3000°	18.0	1
4000°	24.0	1
5000°	50.0	1

Compressive Strength, ksi

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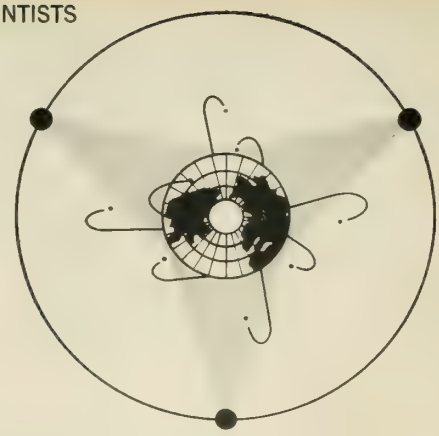
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For the long term, the mission of Intelcom's professional staff is to build and steadily expand a technical capability which will strongly influence the future growth and development of the whole field of satellite communications.

This is an enterprise warranting participation of the finest minds in space systems.

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Consider how they work. This is essentially applied research done on paper, not in a lab. The take-off point in developing system design criteria is to work first with the best that exists today in theory, techniques and equipment—then to proceed to optimize all aspects of the system. New theoretical approaches will be applied. In the almost "academic" atmosphere that prevails here, members of the technical staff are relieved of administrative detail and non-technical responsibilities.

THESE ARE REPRESENTATIVE CURRENT OPENINGS:

SATELLITE COMMUNICATION SUBSYSTEM ENGINEERS — to formulate requirements and test plans, and monitor development of the satellite communication subsystem to ensure compatibility with the overall system requirements; perform studies of transponder configurations and of critical techniques in the area of broadband microwave devices, antennas, propagation, jamming vulnerability; monitor development of the telemetry and tracking RF equipment. (2 openings, one in Washington, the other at our Los Angeles facility.)

ANTENNA SYSTEMS ENGINEER— should have strong theoretical background in the design of large, steerable antenna systems. Work will involve the development of design criteria for antenna systems of advanced performance, and analysis of proposed designs.

COMMUNICATIONS THEORIST—should offer strong knowledge and experience in the application of the formal disciplines of communications theory. Work will involve studies of advanced techniques in information transmission, and analysis of proposed implementations.

TELECOMMUNICATIONS — requires detailed knowledge of telephone, telegraph, data transmission and switching systems, covering principles of operation, design and applications. Experience in military applications will be an advantage.

SYSTEMS ENGINEER (Physicist, Mathematician or EE) — to translate state-of-the-art and extrapolations thereof into specifications-satisfying and optimizing systems configurations; perform trade-off studies of major system parameters. Should have knowledge of probability and game theory, systems insight backed by keen analytic ability in field of specialization.

MODULATION / DEMODULATION ANTI-JAM SPECIALIST — must have detailed knowledge of modulation techniques, AM, SSB, FM, FMFB, PM and anti-jam modulation, demodulation, information theory, etc.

SPACECRAFT ANTENNA DESIGN — calls for background in spacecraft antenna design, particularly in connection with coverage, switching and methods of beam steering.

AIRBORNE POWER SUPPLIES — requires background in spaceborne power supplies, batteries, solar cells, isotope supplies, regulators, converters, etc.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 4 January 28, 1963

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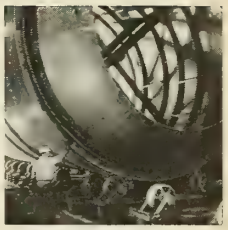
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THE COVER

Largest solid motor case yet built is shown in final assembly at Sun Shipbuilding and Drydock Co., Chester, Pa., whence it will be shipped by barge to Aerojet-General Corp.'s yet-to-be-completed site in Dade County, Fla. See p. 28.



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letters

Omnidirectional Threat

To the Editor:

For those readers concerned with the development of missile defense systems, it is certainly interesting to relate "DOD Says AICBM Is Feasible" (M/R, Dec. 24, 1962, p. 14) with "Air Force Seen Okaying Pluto Tests" (M/R, July 2, 1962, p. 14). From the information in the former article, it appears that our own missile defense planning is based only upon *ballistic* missile defense. This is especially apparent with respect to the "attack corridor" concept for Hard Point Defense (HPD).

An obvious countermeasure by a potential enemy, of course, is to render ballistic-missile-oriented defenses obsolete by saturation with large numbers of re-entry vehicles/penetration aids and/or by attack with a newer delivery system concept such as the *SLAM* nuclear ramjet missile. According to AEC official Irving Hoffman, as quoted in M/R, July 2, 1962, "Any defense posture that he (the defender) may have that would be common for any ballistic missile would not suffice for a low-altitude omnidirectional, high-speed nuclear ramjet missile." Also, he reportedly said that "He (the defender) can no longer fix his defense posture in any one segment. He must look at it from an omnidirectional standpoint."

What defense planning is currently being investigated considering *SLAM*-type vehicles as part of an enemy threat model? How adequate is the "attack corridor" concept for HPD in the context of omnidirectional, low-altitude strike capability of nuclear ramjet missiles? In M/R, July 2, 1962, it was estimated that there might be a *SLAM* flight by 1966. If this is so, it is logical that 1970 would be a reasonable operational availability date. Assuming that the USSR is at least as far along in this development as the United States, it seems reasonable to initiate with increased emphasis studies of antimissile concepts applicable to both ballistic and non-ballistic vehicles.

D. F. Witte
Laboratory for Electronics, Inc.
Monterey, Calif.

Stable Stand

To the Editor:

In the Dec. 24, 1962, M/R, an article under "Industry Week" (p. 37) refers to the stable table assembled for this headquarters by the Geotechnical Corporation of Dallas, Tex., and gives the impression that this system was a proprietary item of Geotechnical Corp.

Actually, this design was conceived and executed under the direction of this headquarters by the Mechanical Research Division of AMF, Niles, Ill.

The services of the Geotechnical Corp. were subcontracted to assemble, test and install the system, which work was handled with the highest degree of technical competence and cooperation.

Louis A. Nees
Chief, Engineering-Construction Division
Headquarters, Air Force Logistics Command
Wright-Patterson AFB, Ohio

Informations, Please

To the Editor:

I humbly request to you that you have the kindness of to publish in your magazine my letter. I put in it my hope of that anybody will aid me.

I am young, of 20 years old nearly, born in Italy, now living in Venezuela. I write this letter for the knowledge of all persons who have some duty (or work) in missiles and rockets and aerospace, and are in authority or can give me some aid.

I wish to obtain free (because I not have so much money as for purchase all thing which I will) informations, photographs, books, booklets, pamphlets, whichever print which can be sent and you will send me.

I had sent many letters to industrial companies, requesting informations and photos on missiles and rockets, but, in some cases, they tell me that, are unable to send it, not have available, or they are not authorized for to send these things. By reasons of this consecuence, I write this letter.

I will make a very big collection of informations and photos of/on missiles, rockets aerospace and other things relationed with these.

I wish photographs and general information on:

Missiles and rockets: designs, types, thrusts, fuels, guidance, etc.

Aerospace: satellites and their work, space vehicles, etc.

Pamphlets, magazines (especially encyclopedia or almanac type) of photos and informations (about all missiles, rockets, satellites, aerospace crafts, etc.).

This is a special call to Informations Directors, Development Chiefs, scientists and all persons who maybe help me in something on my like for this exciting and futuristic profession. I make sure that this cry for help, will not be "great cry and little wool." All the informations and help you can give me will certainly be greatly appreciated.

In a few words: I will to obtain photos and information on all thing which can fly and are made of metal.

I'm waiting for you!

All things, please send to:

Adriano Gressani
Calle Michelena, Nº 96-145
Valencia, Carabobo
Venezuela

M/R is forwarding to Mr. Gressani some of the limited amount of free material we have available. Will others help? —Ed.



ELECTRONICS OPPORTUNITIES

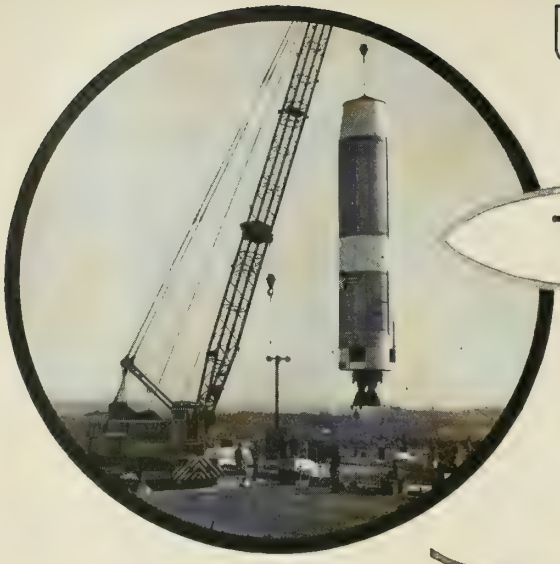
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The precision and unmatched smoothness inherent in UNIT-COLES' design are not the only reasons for leadership in the handling of missiles. "Automated" safety devices — automatic "fail-safe" electro-mechanical brakes, an automatic safe load controller, boom and hook position-limiting switches, and "dead man" type controls — prohibit unsafe lifts, keep the operator within the crane's safety zone at all times, making UNIT-COLES the world's safest crane.

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The Countdown

WASHINGTON

Space Is a Many-Splintered Thing

The $1.6 billion provided for military space programs in the Administration's Fiscal '64 budget is thinly spread. According to Pentagon sources, it covers more than 40 Air Force programs.

Schriever Seen as Chief of Staff

Washington sources say Gen. Curtis LeMay will not be re-confirmed as Air Force Chief of Staff when his term expires next June. Most likely successor: Gen. Bernard Schriever. LeMay is expected to back Gen. Walter C. Sweeney, SAC-trained commander of the Tactical Air Command, as his successor. But insiders believe the Administration will give the nod to Schriever—whose date of rank, incidentally, is a day later than Sweeney's.

Radiation Damage Hits Relay Solar Cell

Radiation damage to an experimental solar cell on the *Relay* satellite has been unexpectedly severe. The damage presumably has been caused by Van Allen belt radiations. Goddard Space Flight Center scientists report that apparently there is some component of the radiation which they have not yet been able to demonstrate in a laboratory.

NASA Evaulating Spacecraft for BIOS Program

NASA now is evaluating spacecraft for its *BIOS II* satellite program. One experiment planned calls for orbiting a primate with a gamma-ray emitter putting out two roentgens per minute for a period of three days. Purpose: to study the combined effects of radiation and weightlessness.

New Data Reported on Venus

U.S. scientists say indications of high temperatures received from Venus may be due to false radio signals. They attribute these to solar winds buffeting the ionosphere of the planet and accelerating the electrons. This is confirmed by unpublished Venus flyby data. Actual surface temperatures remain a mystery. Meanwhile, Moscow Radio quotes Professor A. Mikhailov of Pukovo Observatory as stating that Soviet scientists have detected oxygen lines in the absorption spectrum of Venus. He suggests that the atmosphere of Venus resembles that of Earth in some respects.

INDUSTRY

First Inflatable Flight Set for PARASEV

First flight with inflatable leading edges and keel member is scheduled next month for *PARASEV*, the paraglider research vehicle designed and built by NASA's Flight Research Center at Edwards AFB. The tripod body structure will be the same used in tests with rigid wing booms. A trusswork frame is being built to distribute loads evenly along the keel. NASA, meanwhile, is having problems with development of a full-scale working prototype of the paraglider for its *Gemini* vehicles. As a result, the first manned flight, a ballistic shot, will use conventional parachutes.

Titan III-C to Have More Powerful Transtage

Design of the advanced *Titan III* is believed to call for new guidance on the upper stage and a more powerful transtage unit employing fluorine and hydrazine. Development of the improvements is expected to take 45 months. No initiation of funding is in sight.

Outlook Brighter for Northeast Firms

Prospects for aerospace firms in the Northeast have brightened considerably in recent weeks. Reason: Award of the LEM contract to Grumman and announced plans for an Electronics Research Center. Boston area electronics firms in particular are pleased, claiming the center will have a better and more prolonged effect on the region than the much sought after Manned Spacecraft Center which went to Houston. One effect of the Grumman and Boston awards may be more delay in formation of regional groups aimed at winning more contracts for the Northeast.

A Conference on the Moon

Arthur D. Little, Inc., and Air Force Cambridge Research Labs are jointly sponsoring a conference on lunar surface materials and effects of a simulated environment on postulated lunar surface materials. Some 100 scientists are expected to attend. Date: May 21-22. Place: Boston.

NASA Plans Technical Program for Industry

NASA will begin shortly a program to make its technological discoveries available to industry. The information will be released through publications of the agency's Office of Scientific and Technical Information as well as outside publications. Industry representatives also will be invited to periodic briefings for the same purpose.

NASA Spending At Cape Will Triple

Spending at NASA's Launch Operations Center at Cape Canaveral will triple in 1963 to more than $400 million. Contracts to be awarded include the first launch pad for Complex 39, the launcher-umbilical-transporter tracked vehicle and the Vertical Assembly Building.

Pitt to Build Space Research Center

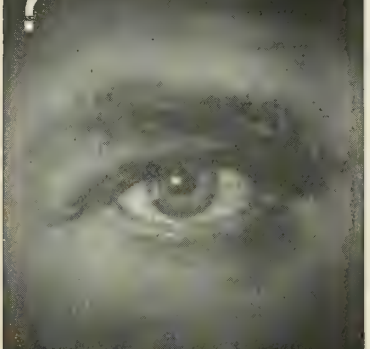
The University of Pittsburgh has announced plans for a $30-million space research and coordination center. One objective: to increase the attractiveness of Western Pennsylvania as a location for space contracts. Some 40 scientists, associates and other personnel are to be hired in the first year of the project.

INTERNATIONAL

Contract Let for Woomera Space Area

A contract has been let for construction of a space vehicle assembly and test area at the Woomera rocket range. This is for the ELDO satellite launch vehicle. The contract provides for a building with facilities for assembling and testing both satellites and vehicles.

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The Missile/Space Week

MIDAS Down But Not Out

Air Force denied reports last week that it has cancelled *MIDAS*, the early-warning satellite system. Reports followed last summer's downgrading of *MIDAS* into a more basic research stage (M/R, July 16, p. 12). One *MIDAS* facility has been scrapped.

MIDAS was reportedly having difficulty with its infrared sensors, designed to distinguish missile exhausts from the Sun. Background radiation also was believed to be a problem.

In a letter to Rep. John Kyl (R-Iowa), the Air Force said: "The Ottumwa (Iowa) facility was to be used as an operational facility of a weapons system under development. It has now been determined that the operational deployment of this weapons system will not be effected." AF now plans to dispose of Ottumwa Naval Air Station, on which it has spent $250,000.

AF replies to queries denied cancellation, and did not even acknowledge that *MIDAS* was the system involved. It did say, however, that R&D on the system will continue.

Polaris Goes to Mediterranean

Polaris missiles may replace *Jupiter* surface-to-surface IRBM's now stationed in both Italy and Turkey (M/R, Dec. 3, 1962, p. 7). There are 30 *Jupiters* in Italy and 15 in Turkey.

Turkish Foreign Minister Feridun Cemal Erkin said last week the *Jupiters* would be withdrawn from his country, but the U.S. State Department would neither confirm nor deny the announcement.

The switch is expected to be made, however, and to be described as furthering the Kennedy-Macmillan concept of a NATO nuclear force as outlined at the Nassau conference.

NASA Satellite Contract Due

NASA expects to select a contractor within a month to develop its new 4000-lb. micrometeoroid satellite.

The prime will be named from among 11 missile/space firms that submitted bids to the Marshall Space Flight Center Jan. 17.

Competing firms are: Fairchild Stratos Corp., General Dynamics/Astronautics, Goodyear Rubber Co., Martin Marietta Corp., Northrop Aircraft Co., Inc., Space General Corp., Space Technology Laboratories, Ling-Temco-Vought, International Business Machines, North American Aviation Inc., and Bendix.

No estimate of the total cost of the program has been released by Agency officials. About $5.2 million has been requested for micrometeoroid satellites in the Fiscal '64 budget, and almost $6 million is available in the current fiscal year. Some of the latter funds, however, will also be used for the small *S-55* satellite project.

The orbit of the satellite—designed to study the effect of meteors and micrometeoroids — will range from 100 to 200 mi. in altitude. It will have an expected lifetime of one year.

Missile for TFX Named

The Navy has chosen the name "Phoenix" for its air-to-air missile to be fired from the new TFX fighter plane, and has awarded Hughes Aircraft Co. a $12.2-million contract to develop the system.

The missile is named for a large bird in Greek and Egyptian mythology. The bird was fabled to live for 500 years, to destroy itself by fire, and to rise again youthfully from its own ashes.

Rockets To Map 'Blind Spot'

The Marshall Space Flight Center will start launching small wind rockets next month in an effort to help fill a gap in knowledge of air movements in the vicinity of 60 mi above Earth.

Considerable information has been gained from larger rockets and satellites about conditions higher than 60 mi.; small rockets have obtained data about conditions lower than 60 mi.

Rocket experts at the Marshall Center want to know more about this "blind" area. Such information would be useful in designing space vehicles and in plotting rocket trajectories.

Marshall recently awarded a $40,245 contract to Rocket Power Inc., Mesa, Ariz., for 15 *Hopi-Dart* rockets that are 76 in. long and weigh about 93 lbs.

Six or eight of the rockets will

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be launched from NASA's Wallops Island launching facility in Virginia. The remainder will be fired from NASA's Launch Operations Center at Cape Canaveral, Fla.

Shots of the Week

A *Minuteman* ICBM traveled more than 4000 miles down the Atlantic Missile Range Jan. 23 for its first flight success of the year. Performance was described as "flawless."

• An Italian team fired a Chrysler *Jupiter* IRBM from Cape Canaveral in a successful training shot Jan. 22.

• A Martin *Pershing* missile—deliberately tilted at liftoff to simulate the buffeting effects of strong winds—successfully straightened out and proceeded to a target area 200 mi. south of Cape Canaveral Jan. 17. The missile was fired from an erector-launcher mounted on an XM-474 tracked vehicle in a test of all-weather capability and the ground mobile mode of operation, required for the tactical version of the system.

• North American Aviation's *X-15* No. 3, piloted by NASA Chief Research Pilot Joseph Walker, made its highest recorded flight without its ventral fin to date—270,000 ft.—Jan. 17. It was also the second highest flight achieved with the rocket plane.

Boston Center Set for '65

NASA hopes to begin construction of its new Electronics Research Center in 1965.

The center will be located in the greater Boston area. Its total cost is estimated at $50 million and it is expected to have a work force of 2000.

All NASA plans for the center hinge on Congressional approval of its funding. For Fiscal '64, only $5 million has been requested for land purchase and planning of the facility.

NASA expects to concentrate at the center all its research in the areas of component technology, data processing, guidance and control, communications, instrumentation and energy conversion.

Saturns Converge on Canaveral

The *SA-4 Saturn* has left Huntsville, Ala., by barge for Cape Canaveral. The 2200-mile trip will take about 11 days. The route covers portions of the Tennessee, Ohio and Mississippi Rivers, the Gulf of Mexico, inland waterway and the Indian and Banana Rivers of Florida.

An *S-IV* second stage for the *Saturn* also is en route to the Cape by water. It left California recently by ship and will travel to Port Canaveral via the Panama Canal.

This *S-IV* is scheduled to be mated to a *Saturn* first stage next spring for the initial ground test of facilities and systems at Complex 37.

Cape Contractors Face Tax

A move is underway by officials of the county surrounding Cape Canaveral to determine whether taxes can be levied on fixtures and equipment owned by missile contractor companies but located on the government reservation.

A Florida law does grant such authority to the counties of the state. However, the attorney general has ruled Federal permission must be granted before the state laws can become effective.

The county must furnish schools and other public facilities for thousands of new residents who will move into the area as construction of lunar launch facilities gets underway.

But as the need for more public facilities has risen in Brevard County, land purchased by the Federal government has vanished from the county tax rolls.

Most county officials agree new sources of taxes must be found if the expanded facilities and services are to be furnished to missile and space workers. They contend that the logical source is private property of missile contractor firms located on the huge government reservation.

Marshall Tower Bids Opened

The Army Corps of Engineers office in Mobile, Ala., has opened bids for construction of support facilities for a *Saturn* test tower being built at Marshall Space Flight Center.

The apparent low bidder was Grafe-Wallace, Inc., Denver, with an offer to do the work for $3,327,418.50. Eleven firms submitted bids.

The contract will cover construction of service systems and a support building. The support facilities will include helium, high-pressure nitrogen and propellant distribution systems, and a building that will be used for engine handling, maintenance and repair.

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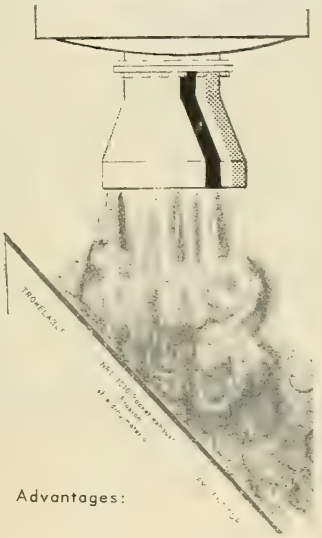
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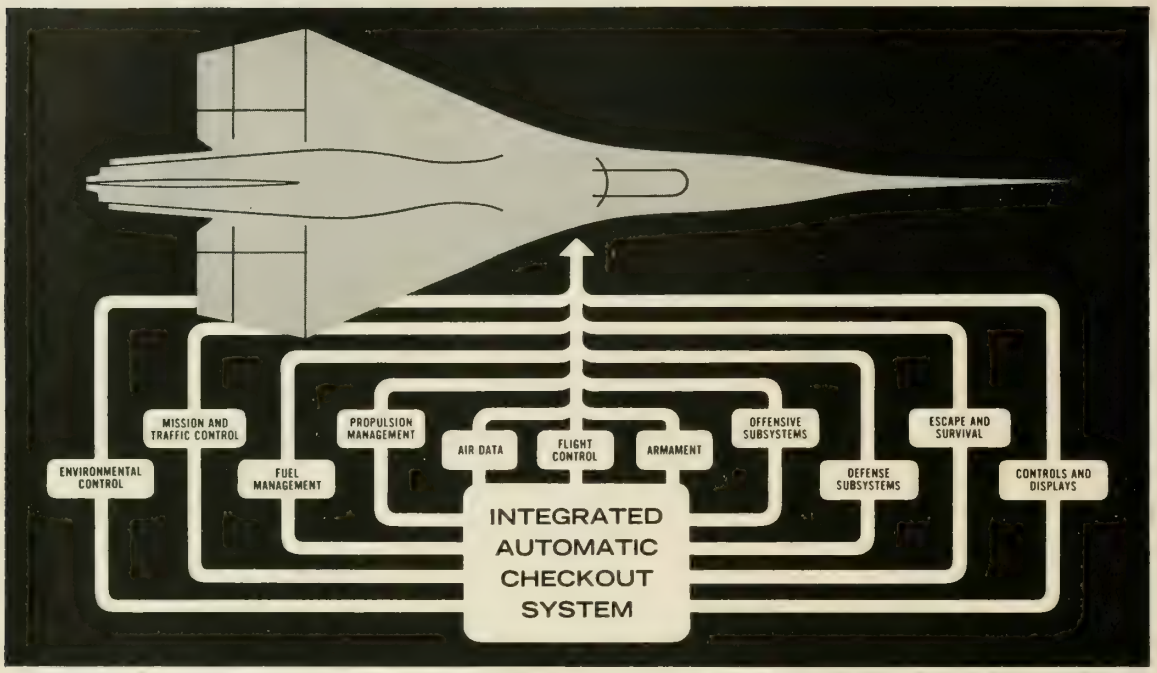
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Will future Avionic Systems



All basic integrated avionic subsystems could logically be maintained with integrated maintenance equipment. This maintenance method would result in considerably more military operational capability per defense dollar.

Radio frequency fault detection at Honeywell

A Honeywell-discovered method of detecting potential circuit failures will provide higher reliability for Honeywell-supplied systems for the Gemini and Apollo Spacecraft. The method has already been proven on the assembly line of Honeywell's F-104 Flight Control System.

Termed "Radio Frequency Fault Detection," the method provides a significant improvement in product reliability by locating potential failures that even X-ray tests would pass as perfect. The slightest imperfection in the electrical circuits generates an RF noise easily detected at approximately 25 Mc on an RF receiver. The test may be applied to entire systems as well as subsystems and components.



A Honeywell F-104 Flight Control System subassembly card is shown being tested by the RF Fault Detection method. The oscilloscope shows an intermittent RF noise produced by a faulty diode in the card.

Airborne computer monitors spacecraft systems in flight

Present-day checkout and maintenance equipment will not be practical for the spacecraft electronic systems of the future. A small, simplified unit carried aboard the craft will be needed.

Such a computer, called Micro Ace (Microminiature Automatic Checkout Equipment), is being developed under a Honeywell-sponsored program which already has resulted in circuit designs capable of monitoring and isolating faulty components in a spacecraft's electronic system. The computer will permit astronauts to monitor systems and predict an impending failure far enough in advance so that faulty components can be replaced before the mission is affected.

be maintenance liabilities?

Is industry meeting its responsibility to simplify avionic maintenance?

Industry's present method of designing military avionic systems has resulted in high-performance weapon systems with excessive maintenance requirements—from 60 to 150 maintenance man-hours for every flying hour. Since only a fully operationally ready weapon system is an effective one, this extensive downtime is a liability. It must be corrected before the weapon systems of the future are designed.

It is an industry responsibility to design weapon systems that provide a maximum state of readiness with a minimum of maintenance cost. To accomplish this, environmental orientation must be instilled into R&D management. These key steps should be followed:

(1) Establish avionics system management to provide unified technical direction and control integration and packaging of avionic subsystems so that they will function efficiently in concert with one another.

(2) Design avionics systems for maintainability. During the initial design phase, maintainability of the system should be given equal consideration with mission performance and operational environment. Maintainability should also rank with reliability as a factor in equipment design. Avionics system management would assure that:

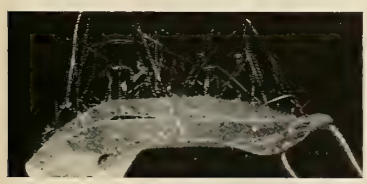
- simple designs are used to reduce maintenance complexity
- built-in maintainability augments reliability
- concurrent design of the support equipment is compatible with the basic concepts of maintainability and operability

(3) Take advantage of technological advances to reduce the need for extensive electronic maintenance by providing high-performance avionics systems with greater reliability and maintainability.(See examples below on RF Fault Detection, Self-Repairing Circuitry and Micro Ace.)

We believe these concepts will prevent the complex electronic weapon systems of the future from becoming maintenance liabilities. Our experience in standardizing both manual and automatic maintenance equipment for different types of supersonic fighters—in addition to allied technological advances and management of military systems—firmly supports this conviction.

For more information on avionic systems maintenance, write Honeywell, Department 671-K, Minneapolis 40, Minnesota.

Self-repairing circuitry may provide automatic repair of space systems



Honeywell is researching two ways of inducing circuitry to repair itself.

The first involves coating electronic circuitry with a special alloy. A small temperature rise at any break would cause the alloy to melt and flow into the break.

The second method (shown above) seeks to control the direction and growth of metallic whiskers (of the type that sometimes form on capacitor plates and produce short circuits) to effect a repair.



Honeywell's Automatic Analyzers provide standardization in performing avionic systems analysis and fault isolation on the Canadian CF-104 (above); U.S. Air Force F-101B; Royal Air Force Lightning; Canadian CF-101; German F-104G; Japanese F-104J; and NASA/U.S. Air Force X-15.

This advertisement is paid for by Honeywell, not from government funds. It is particularly addressed to companies seeking help in areas where Honeywell experience can be most useful.

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With funding trimmed . . .

Space Accord Threatens X-20

AF fears cutback or possible cancellation of program; Titan III prospects unclear; Funk reasserts military needs

by Frank G. McGuire

A TIGHT military space budget and a NASA-Dept. of Defense agreement for Air Force participation in the *Gemini* program has cast a dark shadow over the future of the *X-20 (Dyna-Soar)* project.

A high Administration official told MISSILES AND ROCKETS that *Dyna-Soar* is now being re-evaluated by DOD. Air Force officers openly expressed the fear that the *Gemini* agreement will sharply curtail the *X-20* manned spaceflight program and perhaps even mean its ultimate cancellation.

In the wake of the presentation of the Fiscal '64 budget request, there were these other developments:

• Pentagon officials reported that the *Dyna-Soar* budget for the next fiscal year will be cut back by five percent from its Fiscal '63 level. There were also reports that a cutback in the program may reduce the priority accorded to its *Titan III* launch vehicle program. It is pointed out, however, that the combination liquid/solid-propelled booster is being designed so that it can be used for a variety of missions including manned orbiting space stations and long unmanned interplanetary flights.

• Army's anti-ballistic-missile defenses got a fresh breath of life with the unveiling of the *Nike-X* concept, using a new multi-functional array radar with electronic instead of mechanical scanning, and a mix of high- and low-altitude missiles in the same battery (see p. 16).

• Maj. Gen. Ben I. Funk, commander of AF's Space Systems Division, told the Institute of Aerospace Sciences that the Air Force has a prime military necessity for rendezvous and inspection ability, a communications satellite, and a manned orbital development station.

• NASA and DOD signed another agreement which gives AF management responsibility over the present 15,000-acre Cape Canaveral launch

Text of NASA-DOD Agreement on Gemini—and Beyond

FOLLOWING is the official text of the NASA-Defense Dept. agreement concerning the Gemini program:

THIS DOCUMENT defines the policy agreement for arrangements to insure the most effective utilization of the *Gemini* Program in the national interest.

1. Objectives of the Gemini Program:

The *Gemini* Program constitutes a major portion of the current near-Earth manned space program in the United States. It is the intent of this agreement to assure that the scientific and operational experiments undertaken as a part of the *Gemini* Program are directed at the objectives and requirements both of the DOD and the NASA manned space flight program.

2. Establishment of the Gemini Program Planning Board

A *Gemini* Program Planning Board is hereby established reporting jointly to the Administrator of the NASA and the Secretary of Defense. The Associate Administrator of the NASA and the Assistant Secretary of the Air Force for Research and Development will serve as Co-Chairmen of the Planning Board. The Board will include two additional representatives of each of the two agencies. Members will be named by the Co-Chairman and approved by the Administrator of the NASA and the Secretary of Defense.

3. Functions of the Gemini Program Planning Board

The Board hereby created is intended to assure that the *Gemini* Program is planned, executed, and utilized in the overall national interest, in accordance with policy direction from the Secretary of Defense and the Administrator of the NASA, so as to avoid duplication of effort in the field of manned space flight and to insure maximum attainment of objectives of value to both the NASA and the DOD. The functions of the Board in carrying out this responsibility shall include the delineation of NASA and DOD requirements and program monitoring to insure that they are met in:

1. The planning of experiments.
2. The actual conduct of flight and in-flight tests.
3. The analysis and dissemination of results.

Should actual project plans fail to meet the requirements specified by the Board, or should competing requirements produce resource or schedule conflicts, the Co-Chairmen shall so inform the Administrator of the NASA and the Secretary of Defense.

4. Gemini Project Management

NASA will continue to manage the *Gemini* project. It is, however, agreed that the DOD will participate in the development, pilot training, preflight checkout, launch operations and flight operations of the *Gemini* Program to assist NASA and to meet the DOD objectives.

5. Funding

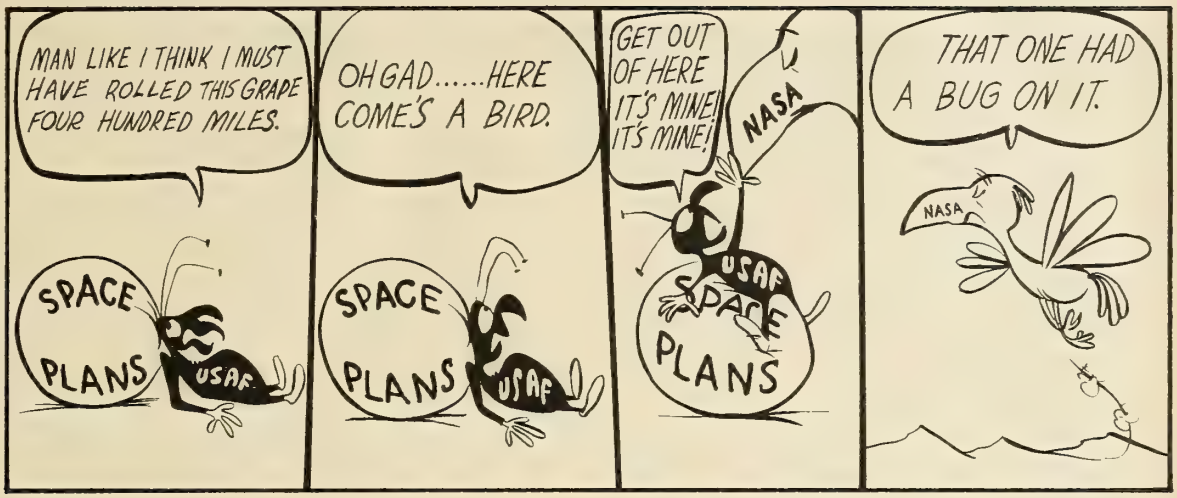
In recognition of its interest in the program, the DOD will contribute funds to assist in the attainment of *Gemini* Program objectives. The amount of such support will be determined on the basis of recommendations submitted by the Board.

6. Additional Programs

It is further agreed that the DOD and the NASA will initiate major new programs or projects in the field of manned space flight aimed chiefly at the attainment of experimental or other capabilities in near-Earth orbit only by mutual agreement.

(signed)
James E. Webb
Administrator, NASA
(signed)
Robert S. McNamara
Secretary of Defense

Did NASA Swallow AF's Plans?



apologies to Johnny Hart

compliments of b. c. comic strip

area and NASA responsibility for the new 87,000-acre launch site for large launch vehicles such as the *Advanced Saturn*.

• **Dyna-Soar uncertain**—A top Administration official said the future of *Dyna-Soar* probably will depend on the successful working of the *Gemini* agreement. An alternative to outright cancellation would be to relegate *Dyna-Soar* to a low-key research program similar to the RS-70. The same source also pointed out that *Blue Gemini* is as good as dead, since DOD certainly will not fund both AF participation in the NASA program and the separate *Blue Gemini*.

But the Air Force is not losing anything it had, the official said. *Blue Gemini* was never an approved program, and there is now the chance that the Air Force will get its own *Gemini* capsules after all. He emphasized that AF funding in the program will not be used to cut down the size of the NASA program. AF money—not expected to exceed $30 million in Fiscal '64—will be used solely for AF equipment and experiments.

One benefit of the agreement, the same Administration spokesman said, is that it probably will make the $5.7-billion NASA FY '64 budget request more palatable to certain Congressional adherents of a strong military space program.

Co-chairmen of the *Gemini* Program Planning Board, established in the Jan. 22 announcement, are Dr. Brockway McMillan, AF Assistant Secretary for R&D, and Dr. Robert Seamans, NASA Associate Administrator.

• **Range accord**—The agreement on management of the Atlantic Missile Range at Cape Canaveral was ordered by the House Space Committee last year. It said that any land purchased by NASA with funds approved by the committee must be managed by NASA.

In general, the agreement signed by Defense Secretary Robert S. McNamara and NASA Administrator James E. Webb says DOD will continue as the single manager of the Atlantic Missile Range which extends from the Cape to the Indian Ocean.

Also, the Air Force, under DOD authority, will continue as the host agency at the existing 15,000-acre Cape Canaveral launch area.

NASA, however, through its Launch Operations Center there will manage and serve as host agency at the new 87,000-acre Merritt Island Launch area north and west of Cape Canaveral.

The Merritt Island site is being developed primarily to handle very large launch vehicles such as NASA's *Advanced Saturn*, which will boost the *Apollo* spacecraft to the Moon.

In their respective areas, DOD and NASA will be responsible for their own logistics and administrative functions such as maintenance, water, fire protection and security.

Most specific mission functions—including preparation, checkout, launch and test evaluation—will be performed by DOD and NASA in their own behalf regardless of location.

Certain fundamental functions will continue to be the responsibility of DOD in both areas. These include scheduling of launches, frequency control and analysis, flight safety, air traffic coordination, range sea surveillance, range search and sea recovery, underwater salvage, down-range airlift, down-range station operation and logistics, and Port Canaveral operations.

The agreement provides that NASA Launch Operations Center, headed by Dr. Kurt Debus, will be the focal point for all NASA relations with the AMR.

It is considered doubtful that NASA will contract with Pan American to run its portion of the range, as Pan Am now does for AF.

• **AF reiterates**—In the wake of the Administration's record budget request, which held so little increase for military astronautics, Air Force leaders struck back at the lax attitude of DOD.

Space-Spending Shares of Fiscal 1964 Budget

	NEW OBLIGATIONAL AUTHORITY			EXPENDITURES		
	1962 actual	1963 estimate	1964 estimate	1962 actual	1963 estimate	1964 estimate
National Aeronautics and Space Administration[1]	1,796.0	3,622.6	5,663.6	1,229.0	2,358.0	4,154.0
Department of Defense	1,284.3	1,617.6	1,667.6	1,028.8	1,421.0	1,622.0
Atomic Energy Commission	147.8	228.9	254.3	130.0	190.6	247.1
Department of Commerce: Weather Bureau	50.7	43.2	26.2	1.0	19.3	44.7
National Science Foundation	1.3	1.5	2.3	.9	1.1	1.5
TOTAL	3,280.1	5,513.8	7,614.0	2,389.7	3,990.0	6,069.3
Research and Development	(3,216.0)	(5,451.0)	(7,564.5)	(2,381.4)	(3,953.7)	(6,003.0)
All other programs	(64.1)	(62.8)	(49.5)	(8.3)	(36.3)	(66.3)

[1] Excludes aircraft technology

The low priority which has been placed on AF space programs drew fire from Gen. Funk in his speech delivered to the IAS.

Funk hailed the *Gemini* agreement with NASA, but pointed out that the military has stringent requirements of reliability and performance which NASA cannot satisfy. He outlined three space programs as "examples of prime military necessity:"

1. Rendezvous and Inspection. He said AF must be able to transfer men and material in bulk—a condition not required in a civilian mission. He added that the military may have to rendezvous with an uncooperative vehicle; and that for efficient inspection, the military must be prepared to capture an uncooperative vehicle even in the face of evasive action or decoys.

2. Manned Orbital Development Station, popularly called *MODS*. The military wants to evaluate man orbiting in a space environment to see what performance can be expected of him.

3. Communications satellite. A commercial communications satellite system requires many channels. A strictly military system, on the other hand, requires few channels, but they must be reliable, global and jam-free. A commercial system, which NASA is encouraging, requires relatively complex ground stations. A military satellite system must function with very simple ground stations. Moreover, a military system must operate 24 hours daily with multiple ground stations for survivability—a condition not required of civilian stations. ⌘

Improvements Brighten Outlook for Zeus System

A VASTLY IMPROVED radar system, a mix of missile types, and a resulting greater flexibility in tactics have won the Army's newest antimissile defense concept greater acceptance at Defense Department levels, but there is still little prospect of early anti-ICBM deployment.

Known as *Nike-X*, or *Advanced Zeus*, the latest version of the Army's twice-successful missile killer will use a multi-function array radar, a mixture of regular long-range *Nike-Zeus* missiles with the *Sprint* in-fighting missile and modified logic circuitry to handle the mixed-missile battery.

Combined, these elements make up what high-level defense officials are now calling a "significantly effective" defense against ballistic missiles—including low-trajectory, low-speed types launched from short range or from submarines.

Being developed in parallel under the new budget, *Nike-Zues* and *Nike-X* are from the same family tree, and many of their subsystems and components are identical. The Army expects to let contracts for development of *Sprint* sometime soon, since results of studies by three competing contractors are due by Feb. 1. North American, Douglas, and Martin-Orlando are coming up with proposed designs; the winner will get a $30-million contract.

• **Sprint**—Major change in airborne equipment for the newest version of the *Nike-Zeus* system (of which *Nike-X* is still considered a part, although the most advanced part) is the addition of the *Sprint* missile. *Sprint*, whose physical size is still classified, will have a higher acceleration rate than *Zeus*, and a shorter range. It is expected to engage targets at low altitudes and be ideal for hard-point defense (HPD) systems, such as missile sites. (M/R, Dec. 24, p. 14).

Virtually no component redesign is required for the higher acceleration rate. The missile is said to have no difficulties with guidance and control, due to its acceleration rate and faster-time-to-target characteristics. Reliable sources said the assumption that *Sprint* has a shorter time span in which to effect flight changes for correct target interception are "not necessarily valid."

• **Radar changes**—The ZMAR system (Zeus Multi-function Array Radar) will be hardened and may consist of only one radar antenna, whereas the previous designs of *Nike-Zeus* have used four mechanically scanning radars. The array radar will make use of all the signature studies of ballistic missile re-entries conducted at the Atlantic Missile Range and Pacific Missile Range, and no new program for this type of data acquisition is planned.

Minor modification of the logic circuitry in the ground equipment is required, in order to allow the battery to effectively utilize two different types of missile. Officials said, however, that this is not a troublesome change; they commented that many more different types of missiles could be mixed into a battery by merely altering logic circuits to make proper use of missiles. Other electronic data-processing equipment is nearly identical for both systems.

Provisions have been made for a radar handoff from one site to another in case a ZMAR unit is knocked out, but Pentagon spokesmen said flatly that an electromagnetic blackout due to a low-altitude nuclear explosion would not contribute to knocking out the effectiveness of the system. The sites will be tied together for the radar handoff, and will also be designed for completely autonomous operation.

Reports that a homing sensor might be built into the *Sprint* missile were discounted on the basis that such a system would have as many disadvantages as it would advantages. Although it appears that a warhead would be an ideal target for an infrared homing device after it has survived the heat of re-entry, the accuracy of the present setup is such that no such supplement is needed.

Decoys expected to accompany an incoming warhead very likely will be stripped away from the nose cone by the atmosphere, because of their different weight and drag characteristics. Declining to discuss discrimination, decoy design and other sensitive aspects of the missile defense system in detail, Defense officials merely said "atmospheric interactions" would make the defense at lower altitudes an easier job.

• **Open-end effort**—First crack at a hostile warhead probably would be taken by the longer-range *Zeus*, then backed up by *Sprint* in event of a miss. Pentagon officials noted that the *Zeus* concept allows for firing in salvoes. In addition to the salvo firing, ZMAR is capable of a 360-degree traverse, giving it added effectiveness against missiles launched from submarines.

Still an open-ended program, the *Zeus* system is still being improved and modified on a day-to-day basis, as experience and tests dictate.

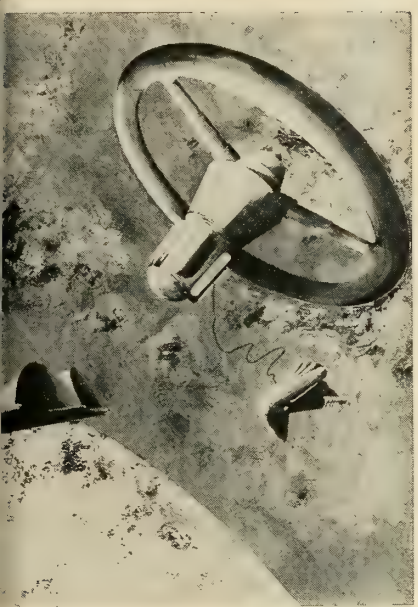
Looking beyond *Zeus*, the Advanced Research Projects Agency (ARPA) has studies under way to research even more advanced missiles than *Zeus* or *Sprint*. Although data gained by ARPA from its missile defense studies have been of great assistance in improving the *Nike* family, the Agency is essentially looking much farther ahead than the Army, which must come up with a system based on existing technology that can be deployed on relatively short notice.

Pentagon sources point out that if this country ever deploys an anti-ICBM system, it will unquestionably be based on the *Nike* family. ⌘

At last IAS meeting . . .

Host of New Space Vehicles Proposed

Nuclear rockets seen desirable for nearly all NASA missions; future booster exhausts may alter upper-atmosphere structure



PARAGLIDER emergency "lifeboat" begins descent from space station while a second undergoes inflation, in artist's drawing of Space-General Corp. concept (see text).

NEW YORK—A bumper crop of new proposals for space vehicles—ranging from a manned nuclear orbital carrier to a paraglider emergency "lifeboat"—were produced at the Institute of the Aerospace Sciences meeting here last week.

As was expected, space sciences and technology were heavily accented during the sessions—the 31st and final IAS annual meeting before the group merges with the American Rocket Society on Feb. 1 to form the American Institute of Aeronautics and Astronautics.

More than 2000 engineers and scientists attended.

A highly topical note was injected when Maj. Gen. Ben I. Funk, commander of the Air Force Space Systems Division, declared that the Air Force has an absolute requirement for getting manned vehicles of its own into space (see p. 14).

• **New space vehicles**—First of the new vehicles outlined at the meeting was a manned nuclear-powered orbital carrier, proposed by Douglas Aircraft Co., that could lift a 150,000-lb. payload into orbit. The carrier would then rendezvous with another ship, transfer the payload, and return to a predetermined landing spot on Earth.

Douglas engineers said four clustered reactors would provide 3,600,000 lbs. vacuum and a lift-off thrust-to-weight ratio of 1.2 for the carrier. They advised limiting g loads to 2 g's for exit and entry and a maximum of 4 g's in emergency.

Safety would be provided by using a central tank of liquid hydrogen, which would be emptied last and provide effective shielding from both neutrons and gamma rays. In addition, the biowell in which the crew lived would be shielded. The engineers also said they thought an internal pressure of 14.7 lbs. would be possible.

A design for a manned orbital space station—halfway between the idea of converting a rocket booster stage and the other extreme of starting from scratch with a large self erecting artificial g station—was propounded by General Electric engineers.

They said an integrated volume station, lifted by *Titan IIIC* or *Saturn B*, would be within 1967 booster capabilities.

In this GE concept, the initial station would be put into orbit. The "arms" would be *Gemini* supply vehicles ferried later and docked at the station. Still later, the station could be turned into an artificial g station by launching another station and a central hub with rigid booms to place between them. This would create a dumbbell which could be rotated to provide artificial gravity. The *Gemini* "arms" of the original station would then move to the center for the new, larger station. The engineers said that a three-year station life was now valid.

Another vehicle proposed was the Space-General Corp. space station escape vehicle (see photo). It would be a one-man capsule for escape from a station orbiting Earth at about 300 miles altitude.

Besides room for the passenger (lying face down), the 27-in.-dia., 10-ft. capsule would contain a life support system for five hours, a guidance and control electronics module, an inflation system pressure vessel and valves.

The capsule would be landed by a 22½-ft. paraglider (apex diameter 32 in.) made of metallic fabric covered by silicone resin. Landing would be accomplished by reducing vertical velocity by a conventional aircraft-flare maneuver. The whole escape package, uninflated and packed, would be attached to the exterior surface of the hub of the space station, allowing the crew member to enter from the space station directly into the crew capsule. Total weight, including a 160-lb. man, would be 944 lbs.

AF Dipole Orbit Revealed

RESULTS OF an Air Force orbital launch of six dipole needles weighing two grams were announced at the IAS meeting by Walter E. Morrow, Jr., of Massachusetts Institute of Technology.

Morrow said the tin needles were put into space sometime last year and have since been tracked. He said results indicate that in spite of the problems involved it appears feasible to achieve reliable digital transmission over dipole scatter circuits with bit E/N_0's approaching 10db.

Air Force, which had made no disclosure of the launching, said later it would release a full report within a week.

North American Aviation representatives described a reusable, horizontal takeoff and landing booster system in the 500,000-lb. class which would place from 10 to 15 tons of usable payload in a 300-mi. orbit. NAA's W. A. Martin outlined four research objectives which would lead to design of such a system.

Lockheed engineers told the conference a Venus flyby mission with a three-man crew of the *Apollo* type might be possible using a single *Saturn C-5* booster coupled with an early-model man-rated nuclear rocket, or perhaps even a chemical escape stage. In discussions which presented trajectory and timing plans for different rocket types, the engineers described this interplanetary travel schedule:

—Low-energy Mars trips of long duration (630-680 days) during any opposition period.

—Short, high-energy Mars flybys

ruled out between 1973 and 1985.

—A limited number of attractive multi-legged planetary flybys, available in the 1970-72 period. The engineers said that although launch windows are rather restricted and timing problems severe, such favorable mission opportunities will not occur again until after 1985.

• **Pilot and crew performances**—NASA Langely Research Center representatives described some three-man crew confinement studies conducted using Martin Marietta simulators.

They found there were no difficulties with test pilot personnel for confinement periods up to 7 days, and that a 26-hour duty cycle with two four-hour sleep periods worked best. Onboard exercise programs helped to maintain physical condition and pilot alertness.

Langley spokesmen also said rendezvous studies showed that man had the visual capability to perform space rendezvous, although studies in actual space would be desirable to complete the results. However, they said that preliminary information was sufficient to design missions to the extent of man's capability.

• **Upper atmosphere**—The Earth's upper atmosphere may be significantly affected by the exhaust products of large rockets. These products, moreover, may bring about changes in the world's weather, predicted Jerome Pressman, manager of atmospheric physics at the Geophysics Corp. of America.

This is because the amount of exhaust products the next generation of rockets is expected to deliver to the upper atmosphere may be of the same order as existing minor constituents at certain levels. Studies have shown that even minor constituents in the upper atmosphere can cause major effects.

A minor constituent such as ozone, for instance, in a concentration measured in parts per million at 15-30 km determines the temperature structure of the middle atmosphere. Nitric acid in amounts as little as 10^5 particles per cm^3 (or 10^{-8} of the ambient density) is responsible for the ionospheric D-region.

Studies indicate that the hold-up time of material in the upper atmosphere is surprisingly long, Pressman pointed out. He emphasized the strong probability that the accelerated rocket program with enormously larger missiles in prospect may cause modifications of the upper atmosphere over large local areas or on a world-wide basis. These modifications include changes in composition, temperature structure, light emission and ionosphere.

In view of the possible changes, the scientist said, "It is mandatory to evaluate now what may be a serious problem in the future."

• **Nuclear propulsion**—Despite lack of an approved space mission for the nuclear rocket, Harold Finger said if nuclear stages were available today, "they would be included in almost all of our rocket vehicles."

Finger, head of the joint AEC-NASA Space Nuclear Propulsion Office, said this means the rocket would be used universally, and would not be tied down to any particular missions.

Finger nevertheless outlined major missions particularly suited to the nuclear rocket:

—Mars manned landing mission—a mission that cannot be done by conventional chemical combustion rockets. A nuclear-propelled spacecraft is either established or assembled in an Earth orbit. The spacecraft is then propelled to an orbit around Mars, jettisoning hydrogen propellant tanks as they are emptied.

A Mars excursion module (MEM) lands on Mars and then returns the exploration party to the orbiting spacecraft. The spacecraft is then propelled back to Earth orbit by a nuclear rocket system.

—Preliminary to the Mars landing, a circum-Martian orbit for a limited period to permit manned observations.

—An operational version of *RIFT* for a Venus flyby.

—Unmanned interplanetary probes.

Lunar-orbit reusable ferry. An operational version of *RIFT* stage with payload would shuttle between lunar and Earth orbits.

—Jupiter flyby.

• **Re-entry guidance and control**—A summary by Rodney C. Wingrove of NASA's Ames Research Center indicated that design of advanced guidance systems will be largely determined by available on-board computer technology and the establishment of the role the pilot is to play in effecting re-entry maneuvers.

Guidance systems designed around stored and pre-computed nominal trajectories require minimum computer complexity and can be built to handle off-design flight plan deviations. However, these systems generally provide little guidance display for the pilot.

In contrast are systems using predicted capabilities wherein there is a choice between a number of paths to follow to landing within boundary conditions. Repetitive fast-time prediction methods provide a flexible guidance scheme able to handle any flight condition. Pilot decision-making provisions are high, with range, heating, acceleration, and altitude display providing data to evolve new trajectories. The main disadvantage, naturally, is stringent on-board computer requirements: studies indicate rapidly changing re-entry conditions demand repetitive predictions every 5-10 secs.

• **Space material problems**—Results of a Lockheed Missile and Space Co. study of four key material and component behavior areas in partially simulated space environments were revealed.

1) Lubrication of small ball bearings under vacuum—Of the oils tested, *Apiezon K* lubricated bearings are still operating after slightly more than 21 mos. *Versilube F-50* is still lubricating after 17 mos., and provides much lower bearing torque than the former. Predominant mode of failure with 21 oils tested has been loss of lubricant, with subsequent wear.

Of the greases, *Aeroshell 15* has proved most satisfactory, still lubricating after 14 mos. Most failures due to loss of oil from the grease thickener, which clogs bearing with hardened residue.

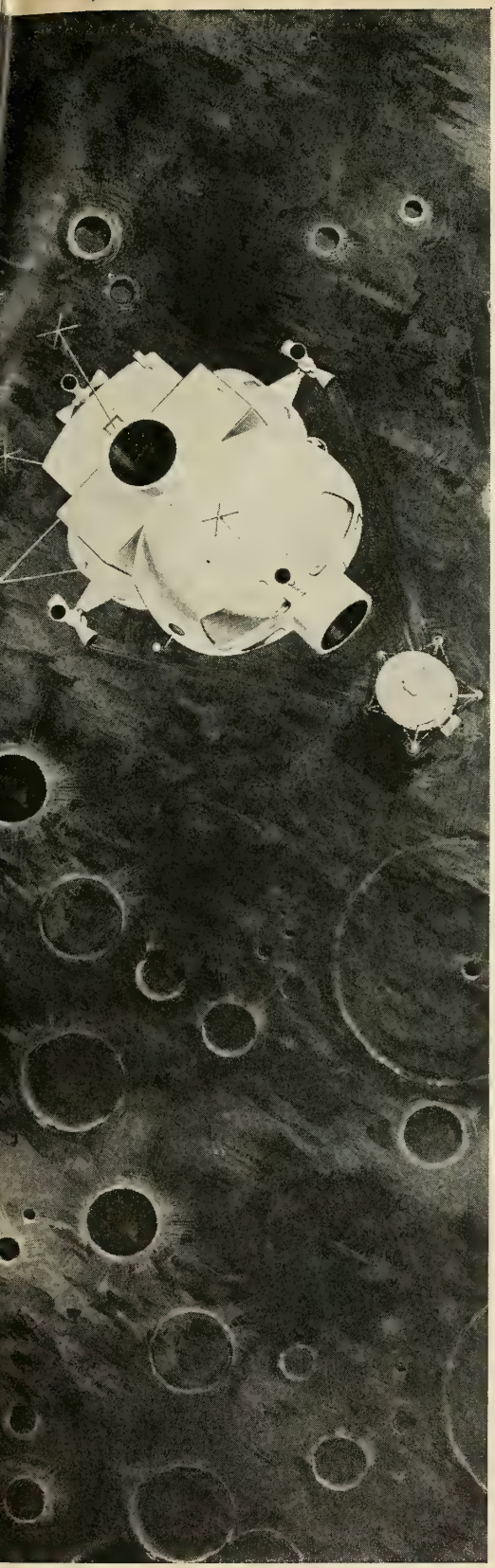
Bonded films of *molybdenum disulfide* have showed lifetime to 3 mos., but are subject to considerable scatter and marked reduction in lifetime by heavier loads and by operating under stop/start/reverse conditions. Film wear-out caused most failures.

2) Electrical noise from sliding contacts—A small partial pressure of oil vapor significantly reduced electrical noise in metal-to-metal contacts in a hard vacuum. The oil can be vacuum-impregnated into a porous material that is fastened inside the enclosure containing the slip ring, and is slowly released during operation to maintain the small amount of vapor required.

Alternate solutions may lie in selection of ring and brush materials. Best performance in vacuum was achieved through use of $88Ag{:}12MoS_2$ brushes on either fine silver or rhodium-plated silver rings.

3) Encapsulating materials—Tests conducted to evaluate encapsulating materials for spacecraft equipment showed two materials to be most stable under exposure to vacuum, temperature, and radiation: *Epocast 202/9615*, and *Hysol 12-007 A/B*. Three others were stable also, though no radiation tests were made: *PRC 1535 A/B*, *DC 502/501*, and *Epibond 1210/9615*.

4) Optical stability under UV radition—Effect of UV on thermal-control surfaces indicates white paints generally undergo an increase in the values of alpha and the alpha-over-epsilon ratio, with organic base paints being more affected than inorganic ones. UV radiation can also cause degradation (severe loss in transmission) of adhesive-bonded solar cell cover plates of clear, fused silica. ❖



LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

The selection of Grumman to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon, opens a new chapter in the conquest of space. Boosted by a three-stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface.

Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all times. Current requirements are detailed on the next page. We invite your inquiry on the attached inquiry form or by personal resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR-86.

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Temperature Control Engineers — BS or MS and 2 years experience to handle space vehicle temperature control system analysis. Should have background in radiative heat exchange and thermal coatings as applied to passive and active temperature control systems.

Electronic Cooling Engineers — BS or MS and 2 years experience to perform challenging work on both high density air and liquid cooled electronic equipment, and electronic equipment which must operate in a vacuum. Must be able to perform detailed analyses of equipment cooling requirements and initiate necessary thermal tests.

Internal Aerodynamicists — BS or MS in AE, ME with minimum of 3 years experience in Fluid Dynamics work applicable to liquid rocket propulsion systems, nozzle flow analyses, pressurization system design, throttling performance; injector and thrust chamber propellant flow analyses.

Gas Dynamicists — BSME or MS with minimum of 3 years experience and capability to perform analyses and tests of reaction jet control systems, jet exhausts, and gas lubricated bearings.

Reaction Control Engineers — BS degree plus a firm background in small liquid rocket engines, analysis, and testing. Will be responsible for the development of liquid rocket attitude control system for manned space vehicle.

Test Analysis Engineers — BS degree plus 3 to 5 years direct rocket test experience, to work on manned space propulsion liquid rocket engines and propellent systems. Must have ability to plan test programs and analyze test results to evaluate overall performance characteristics.

Rocket Propulsion Engineers — Engineers with 2-5 years of direct experience in the analysis, design, development, and testing of liquid rockets. An advanced degree and additional experience in propellant analysis, IBM programming, and proven ability in the field of liquid rocket engines is required. Work involves development of manned liquid rocket propulsion systems. Supervision capability is very desirable. Both junior and senior positions available.

Programming Specialists — B.S. or M.S. in engineering, physics or mathematics with 4 years experience in Electronic Data Processing. To generate original programs and analyze coding of existing programs. Knowledge of IBM, 7090 and 1620 machine coding is considered essential. Programs involve matrix algebra operations, time dependent solutions and integrations. Experience in analog-digital programming would be useful but not essential.

Acoustics & Environmental Vibration—B.S. or M.S. in M.E. or A.E. with a minimum of 3 years experience in environmental vibration analysis of Aerospace structures and equipment. Vibration or acoustical testing experience is desirable. Opportunity to work on environmental vibration design problems in spacecraft.

Vibration Test Engineers — B.S. or M.S. in A.E. or M.E. with 2-5 years experience in vibration testing. Will plan and conduct vibration tests on spacecraft; analyze and interpret data, write reports; perform vibration analyses required in support of test. A working knowledge of current instrumentation, measuring and recording devices and techniques is required. Opportunity to perform original work, assume responsibility and travel to perform tests in outside facilities.

Space Dynamicists—B.S. or M.S. in Physics, Applied Math. or Applied Mechanics, with a minimum of 5 years experience in the analysis of flight dynamics with at least 2 years experience in space dynamics, e.g. disturbance torques, orbital mechanics, lunar trajectory analysis, and separation system dynamics.

Guidance Dynamicists — B.S. or M.S. in A.E., E.E., M.E. or Applied Mechanics with a minimum of 2 years experience in the analysis of guidance systems for spacecraft. To analyze and evaluate functional configurations and dynamic characteristics of radar, IR, optical and inertial guidance loops; signal processing and error analysis. Background in sample-data and non-linear controls systems analysis techniques is desirable.

Control Dynamicists — B.S. or M.S. in A.E., E.E. or M.E. with a minimum of 2 years experience in analysis of control systems for spacecraft. Will evaluate automatic flight control system stability and performance. Familiarity with non-linear techniques, digital control techniques and adaptive control techniques is desirable.

Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all time. Mail the attached inquiry form to Mr. W. Brown, Manager, Engineering Employment, Dept. GR-86.

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PROFESSIONAL PLACEMENT INQUIRY

For your convenience and to facilitate your inquiry, please use this form. It will enable the professional staff at Grumman Aircraft to evaluate your background and experience and arrange for a mutually convenient personal interview. All inquiries will be held in strictest confidence. Enclose in an envelope and send to Mr. W. Brown, Manager, Engineering Employment, Dept. GR-86, Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

NAME_____

STREET ADDRESS_____

CITY & STATE_____ TELEPHONE_____

NEAREST MAJOR CITY (IF APPLICABLE)_____

COLLEGE GRADUATE: YES__ NO__ Degree Subject Year

_____ _____ _____

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_____ _____ _____

_____ _____ _____

Major Speciality_____ Yrs.____ Other Speciality_____ Yrs.____

Applying for position(in)(of)_____

Background and experience (Brief resume of experience, recent history of employment)

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WHY
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Among NASA FY '62 contractors...

North American Far Out in Front

California takes 47% of all direct procurements over $25,000

NORTH AMERICAN Aviation, Inc., with awards totaling $199.1 million, heads the list of top NASA contractors in Fiscal 1962.

Contracts with the firm represented almost 19% of the $1.053 billion in goods and services which NASA procured from business in the twelve-month period ending June 30, 1962.

Other firms comprising the top ten space agency contractors include McDonnell Aircraft Corp., $68,470,000; Douglas Aircraft Corp., $68,374,000; Aerojet-General Corp., $66,393,000; United Aircraft Corp., $34,057,000; Chrysler Corp., $31,294,000; General Dynamics Corp., $27,937,000; Ling-Temco-Vought, $27,042,000; Grumman Aircraft Engineering Corp.; $24,586,000; General Electric Corp., $22,995,000.

Total procurement during Fiscal '62 by the space agency reached $1.551 billion, 105% more than in Fiscal '61. Apart from the business sector, contracting areas included non-profit institutions, $50.2 million; Jet Propulsion Laboratory, $148.5 million; and other government agencies $321 million.

Details of NASA contracting during the last fiscal year were revealed in the agency's annual procurement report published on Jan. 22, 1963.

• **Falloffs**—The report disclosed a drop in Fiscal '62 in both small business participation and competitive procurement.

Of the direct awards to business, only 12% or $123 million were placed with small business. In Fiscal '61, small firms had 15% of the awards. Officials blamed the drop in part on the fact that small business submitted fewer bids in Fiscal '62.

NASA's use of competitive procurement dropped 10%. In Fiscal '62, $566 or 55% of the total contracts to business were awarded through competitive procedures. In 1961, the total was 65%. Fiscal '62 use of non-competitive procurement totaled $464.3 million—45% of the total compared to $146.5 million and 35% chalked up in Fiscal '61.

A breakdown of types of contracts revealed a continued reliance on the cost-plus-fixed-fee award. Of all contracts over $25,000, 82% or a total of $748.6 million were CPFF. Firm fixed-price contracts amounted to 14% or $125 million. Other types of contracts accounted for 4%, with various "incentive" awards totalling about $4 million.

• **Golden State leads**—A geographic breakdown revealed that California is by far the biggest beneficiary of the peaceful space program. Firms and institutions in that state received 47% or $441.2 million of all direct procurements with a value of over $25,000.

No other state was even close. Alabama, in second place, received only $81.2 million or 9% of the total NASA spent.

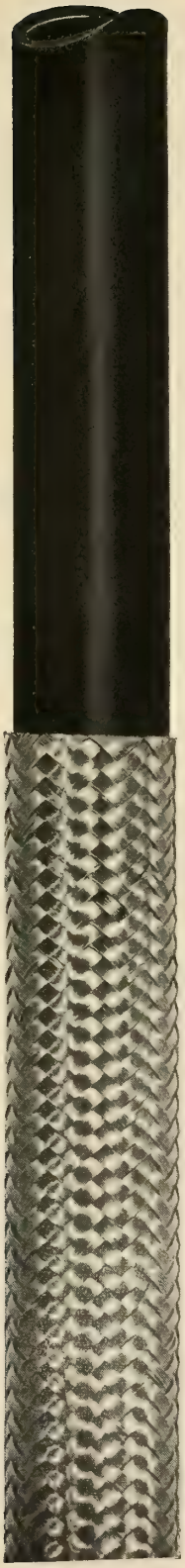
Other leading states included Missouri, $70.6 million; New York, $55.3 million; Florida, $50.9 million; Texas, $32.8 million; New Jersey, $27.0 million; Maryland, $26.8 million; Pennsylvania, $25.3 million; and Massachusetts, $19.7 million. ■

Top Fifty NASA Fiscal 1962 Contractors

FY '62 Rank	Contractor	FY '63 Contracts (thousands of dollars)	Percent of Total Awards to Business
1	North American Aviation, Inc.	199,109	18.9
2	McDonnell Aircraft Corp.	68,470	6.5
3	Douglas Aircraft Co., Inc.	68,374	6.5
4	Aerojet-General Corp.	66,393	6.3
5	United Aircraft Corp.	34,057	3.2
6	Chrysler Corp.	31,294	3.0
7	General Dynamics Corp.	27,937	2.7
8	Ling-Temco-Vought, Inc.	27,042	2.6
9	Grumman Aircraft Engineering Corp.	24,586	2.3
10	General Electric Co.	22,995	2.2
11	Radio Corporation of America	20,187	1.9
12	Bendix Corp.	19,412	1.8
13	Boeing Co.	15,584	1.5
14	Space Technology Laboratories, Inc.	13,248	1.4
15	International Business Machines Corp.	12,634	1.2
16	Brown Engineering Co., Inc.	11,932	1.1
17	Hayes International Corp.	10,990	1.0
18	Hughes Aircraft Co.	9,178	.9
19	Western Electric Co., Inc.	8,695	.8
20	Republic Aviation Corp.	6,931	.7
21	Lockheed Aircraft Corp.	4,951	.5
22	Motorola, Inc.	4,889	.5
23	Minneapolis-Honeywell	4,681	.4
24	Packard Bell Computer Corp.	4,570	.4
25	Union Carbide Corp.	4,386	.4
26	Philco Corp.	4,379	.4
27	Rust Engineering Co.	4,174	.4
28	Electronics & Missile Facilities, Inc.	4,050	.4
29	CompuDyne Corp.	4,011	.4
30	Thompson Ramo Wooldridge, Inc.	3,837	.3
31	Collins Radio Co.	3,669	.3
32	United Engineers & Constructors	3,643	.3
33	Calumet-Hecla Inc.	3,571	.3
34	Westinghouse Electric Corp.	3,433	.3
35	Air Products & Chemicals, Inc.	3,385	.3
36	Blount Bros. Construction Co.	3,348	.3
37	Radiation Inc.	2,488	.2
38	Arthur Venneri Co.	2,476	.2
39	Ball Bros. Research Corp.	2,309	.2
40	Int'l Telephone & Telegraph Corp.	2,207	.2
41	Sperry Rand Corp.	2,160	.2
42	American Telephone & Telegraph Co.	2,138	.2
43	Management Services, Inc.	2,094	.2
44	Ampex Corp.	1,941	.2
45	Doyle & Russell	1,889	.2
46	Federal-Mogul-Bower-Bearings, Inc.	1,851	.2
47	Martin Marietta Corp.	1,844	.2
48	Consolidated Systems Corp.	1,820	.2
49	Washington Technological Associates	1,735	.2
50	Vitro Corp. of America	1,646	.2

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STRATEGIC WEAPONS. Titan I—hard-based ICBM, operational in underground silos on schedule. Titan II—most powerful ICBM: storable propellants, near instantaneous reaction, silo launched. Highly successful test program. Nearing operational readiness.

SPACE BOOSTERS. Titan II Gemini Launch Vehicle. Titan III Standard Space Launch System—over 2,500,000 pounds of thrust; envisioned as the space "workhorse" for the next decade.

SOLID PROPELLANT WEAPONRY. Pershing—fast accelerating system; built to fire almost instantly under rugged field conditions. Finest test record of any missile—37

APABILITY...17 YEARS OF EXPERIENCE

complete successes in 44 launches. Bullpup—the nation's only supersonic air-to-surface missile, so reliable it is handled like a round of ammunition without pre-flight check-out. Lacrosse—with pinpoint accuracy. All three on duty with Army, Navy, or Air Force.

HARDBASE ACTIVATION. Responsible for hardbasing Titans I and II—history's most difficult construction feat. Completed on schedule for Titan I. Progressing on schedule for Titan II.

RE-ENTRY BODY DEVELOPMENT. Specifically, Pershing —ablative nose cone which withstands rapid acceleration, deceleration and high re-entry heats.

NUCLEAR POWER SYSTEMS. SNAP generators for land, sea, and space systems—world's first in space, first undersea, first lighthouse, first weather station. Portable reactors at Sundance, Wyoming, and South Pole.

AIR DEFENSE AND COMMUNICATIONS. Missile Master and BIRDiE electronic air defense systems operational in 29 major metropolitan areas. RACEP communications system, providing direct-dialing, telephone-type service for 700 simultaneous conversations on a single frequency channel without wires or central switchboard. Missile command and control systems, ASW systems.

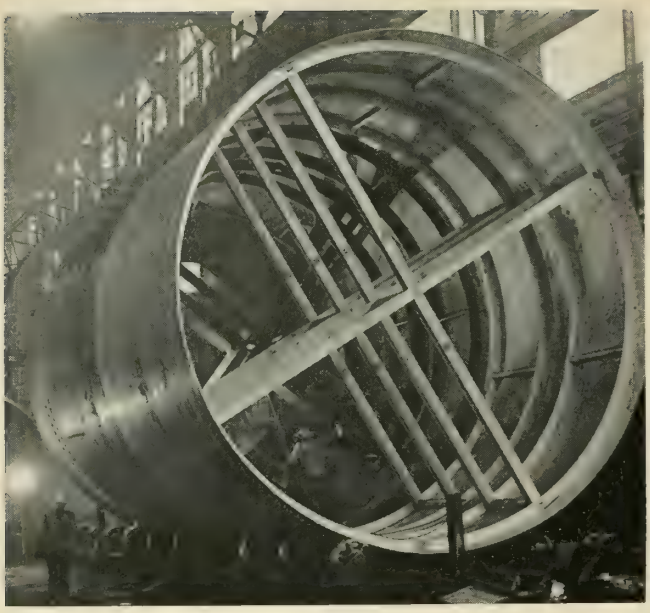
MATERIAL DEVELOPMENT. Exotic materials, with high heat flux, high strength with low weight. First production technique for fusion welding of high-strength aluminum alloy. Isotopic fuel forms, tubular fuel elements. Semiconductor materials research, microelectric elements, cryogenics, ceramic heat shields, plastics, surfex, molybdenum honeycomb.

APPLIED RESEARCH. Advanced work in hypersonic aerodynamics. Cryogenics, lasers, masers, celestial mechanics, guidance, quick reaction controls, stability, structures, millimeter wave theory, thin films, infrared detectors, computer technology, thermoelectricity, mission simulation, mathematics, checkout systems, advanced fabrication, solid state.

SYSTEMS MANAGEMENT. In the past five years, 1957 to 1962, Martin has delivered $3 billion in total contracts. $2.9 billion were completed at or under contract cost. $2.8 billion on or ahead of schedule.

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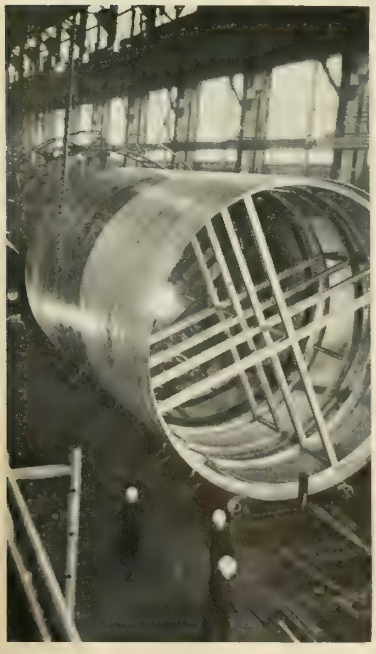


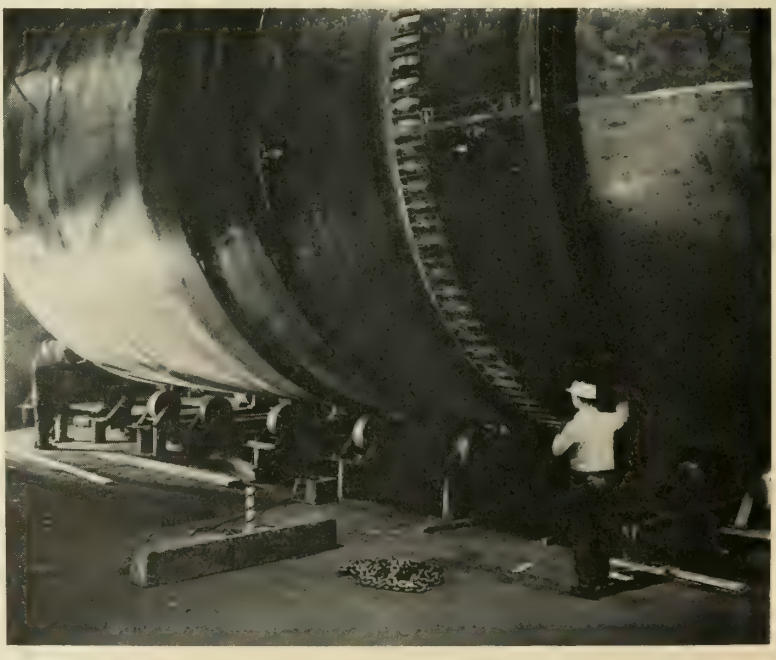
Aerojet Funds 280-in. Solid Rocket Case

PROPOSED HANDLING concepts for big solid boosters will be checked out on this massive 280-in., 60-ft.-long motor case by Aerojet-General Corp.

Shown here in the final assembly stages at Sun Shipbuilding and Drydock Co., Chester, Pa., the unit will be barged to Aerojet's Dade County facility in Florida via the intercoastal waterway. A low-carbon steel was chosen since its fabricating characteristics resemble that of the maraging steels to be used in flightweight boosters.

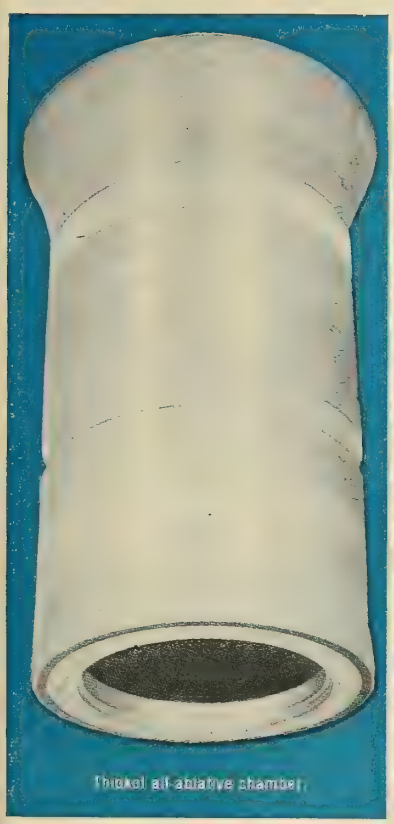
Once in Florida, Aerojet will insulate, line and partially fill the 94-ton case with inert propellants for handling purposes. David S. Sprenger, manager of Aerojet's large solid program, says the program will save six months of work if the firm wins a contract in the large booster area. Existing barge facilities will be used to ship the case.

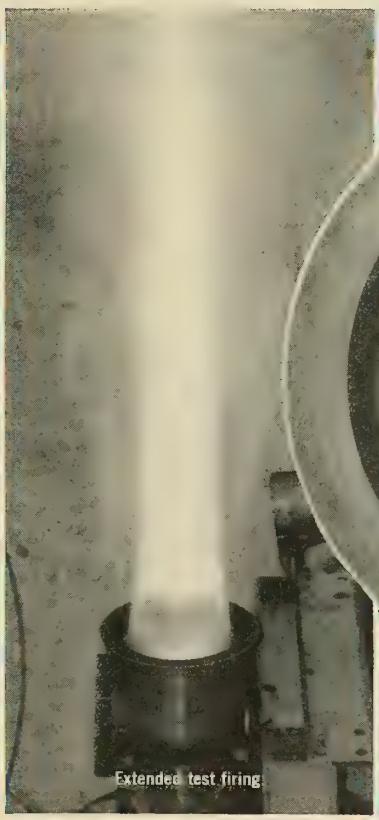


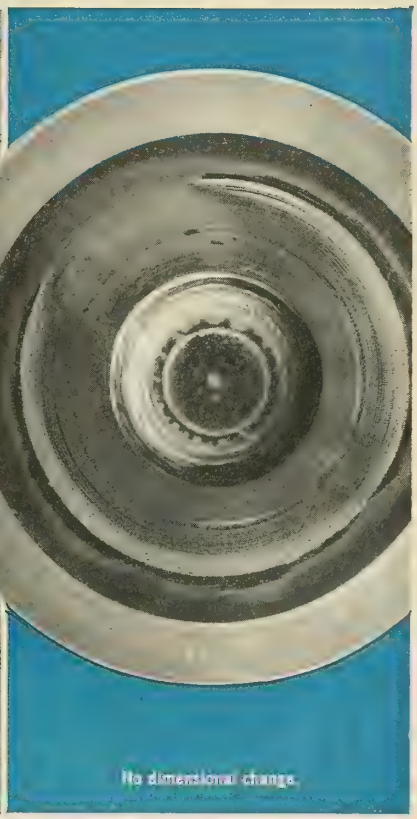


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Performance proved above 97% theoretical in multiple tests by Thiokol

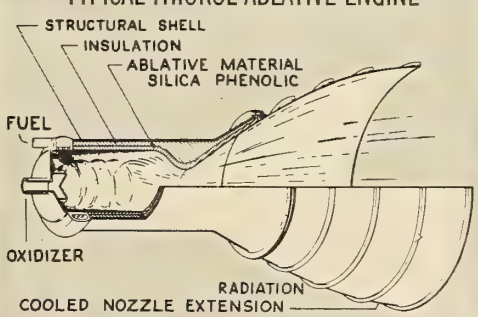
Using advanced injection techniques, plus the newest rocket-engineered chamber materials, Thiokol is making important progress in ablative technology.

One all-ablative engine has already been fired over 14.5 minutes. Another—an ultra-lightweight space version throttleable over a 40:1 range—was successfully tested at chamber pressures and combustion temperatures of actual lunar operations. Both engines remain suitable for continued service. Ablation rates are exceptionally low and performance, consistently above 97% theoretical.

Their unique throttling injector—providing maximum propellant recirculation, mixing and combustion stability—delivers high performance durability. There is no chemical or thermal streaking of the ablative liner.

The Thiokol engines are 20% lighter than comparable ablative systems of conventional design. *Ablatalite*—a castable, low density insulating material developed by Thiokol—saves many extra pounds in engine weight.

TYPICAL THIOKOL ABLATIVE ENGINE



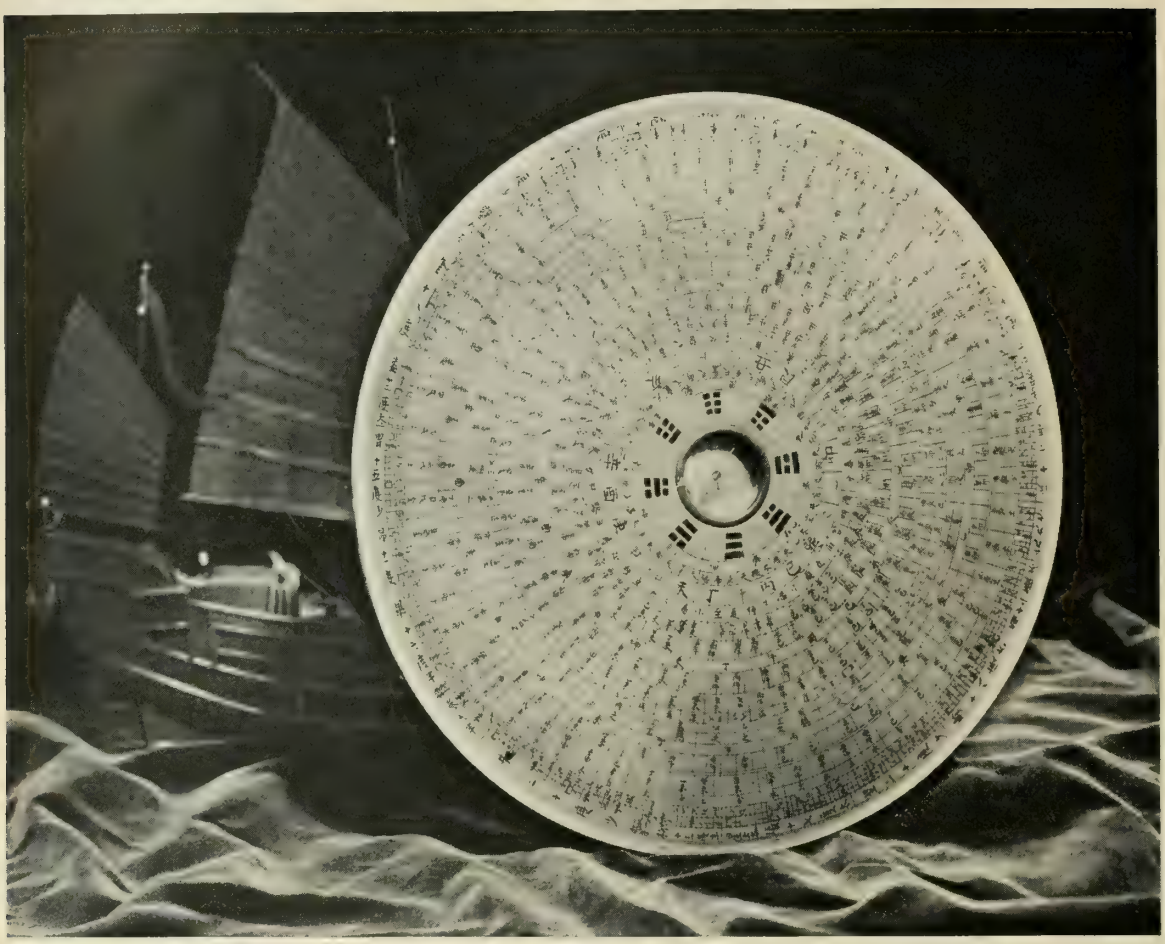
Thiokol

CHEMICAL CORPORATION

Rocket Operations Center: Ogden, Utah

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FROM ANCIENT COMPASS TO TITAN



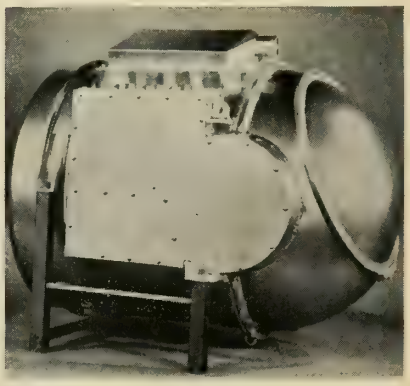
Astrologer's Compass (China—19th Century)—Although the Chinese invented the compass, it was the Arabs who first adopted it for navigation. The characters on this compass are a compendium of astronomical and terrestrial lore. (Cranbrook Institute of Science)

RAPID DEVELOPMENT, LOW COST AND ACCURACY —AC SPECIALTIES

Early navigational devices helped provide the knowledge for the development of today's precision guidance systems, like AC's all-inertial guidance package for the TITAN II. This system, developed in rapid time, featuring miniaturized components, is helping to keep the TITAN on a timetable for operational readiness. At the same time, this system is scoring an outstanding record of reliability and accuracy. The ability for rapid development, at low cost, with outstanding accuracy is now being applied to the USAF TITAN II and III, and NASA's APOLLO systems, as it has been successfully applied to the THOR, MACE, REGULUS and ALRI systems and POLARIS inertial components. Weapon System Integration, and production of major components of the Bombing Navigational System for the B-52 C & D aircraft are also among AC accomplishments.

Perhaps AC's capability in systems development, production and management can help you. We welcome the challenge to prove our capabilities in low-cost development, outstanding accuracy and minimum time to first flight.

THE TITAN II INERTIAL GUIDANCE SYSTEM—AC builds the ALL-INERTIAL GUIDANCE SYSTEM that performs the job of measuring missile acceleration and converting this data into velocity and distance in order to compute steering and engine cut-off commands.



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Technical Countdown

ADVANCED MATERIALS

Pyrolytic Graphite Plasma Sprayed

Space Age Metals Corp. is fabricating large pyrolytic graphite sections and structures without regard to size limitations and at a rapid rate through a proprietary plasma spray concept. Complete pre-orientation can be achieved since the crystal lattice layers of graphite can be controlled to conduct heat to any section of the design desired. In a nozzle configuration, the heat can be directed back into the engine, or out the bottom of the nozzle, or be absorbed within the large section of the piece as a heat sink. Company spokesmen claim large structures can now be machined from spray-formed solid blocks of the graphite.

GE Cracks Aluminum Lubrication Barrier

Information on friction processes provided by ultra-high vacuum research for space purposes is leading to the identification of new compound classes for aluminum lubrication at General Electric. Friction results comparable to the best babbitt bearings are being achieved with the classically lube-resistant metal through chemically bonded coatings. GE researchers would not reveal the chemical nature of the compounds but disclosed that several organic classes have been identified as having the required properties. These may be used either in the pure form or as compounded additives.

Thin Film Analyzer Perfected

A mass spectrometer capable of extracting and analyzing atoms from surface areas 1 mm^2 in size is in commercial production at Geophysics Corp. of America, Bedford, Mass. Based on the design of an instrument developed to handle dust particles brought back from instrument probes landing on the lunar surface, the unit bombards sample atoms with high-speed argon ions. The mass spectrum is obtained by injecting the ionized unknowns into a double focusing, anastigmatic mass spectrometer, Applications include the analysis of lenses, radio tubes and electronic components.

Space Structure Development at de Havilland

A number of useful, extendable space structures, utilizing the principle of the steel tape measure, have been developed by the Special Products and Applied Research division of de Havilland Aircraft of Canada, Ltd. John D. MacNaughton, division chief mechanical development engineer, told the recent American Astronautical Society meeting that a long, flat strip of thin, flexible metal, which forms a rigid overlapped tube when uncoiled from a storage drum, can be used to form a variety of space structures. The de Havilland device, used for antennas on several satellites, represents the solution of complex engineering problems allowing application of the principle to booms for spacecraft docking, retractable mechanical arms, liquid transfer lines and basic structural members, MacNaughton said.

ELECTRONICS

Avco Studies Long-Range Solar Probe

Scientists in Avco Corp.'s Space Vehicles Project Office at Wilmington, Mass., have speeded company studies on techniques for close-approach solar probes. Looking beyond NASA's *Pioneer* space probe (M/R, Jan. 21, p. 29), Avco is studying design of a craft to measure solar fields and particles from distances within a few solar radii, or about 1/10 of an astronomical unit. Possibly 10 years away, the craft would probably require a high-power electrical propulsion source. Though guidance requirements may not be too severe, problems with attitude control, thermal protection—and particularly instrumentation—require major study. Scientists explain that rather than attempting direct solar-spot instrument readings, it may be more valid to transmit through the corona or past the fringe of the sun to another orbiting satellite or possibly to a Moon base.

Philco Will Build NORAD Data System

NORAD's Alaskan region will be provided with a wall-sized, four color, automatic display and data-processing system under an $8 million Air Force contract with Philco. The AN/FYQ-9 system will permit up-to-the-second information vital to defense decisions. Philco's Philadelphia area facilities will perform the work under the management and direction of Air Force Systems Command's Electronic System Div. 416L program office. The system accepts, processes and displays data in standard manual formats, symbols and color coding as needed.

No SPADATS Assist From Arecibo Antenna

Contrary to rumors, the 1000-ft.-dia. fixed, spherical antenna located near Arecibo, Puerto Rico, will not be employed for military surveillance of near-Earth space. The system, according to reliable industry informants, was designed solely for deep-space radio research and cannot follow an orbital target fast enough. Nor would it be a practical device for studying man-made electromagnetic radiations from Earth, they assert. The antenna employs a movable offset feed horn, mounted on a cable slung track, to obtain a maximum sky coverage of 40° (solid angle).

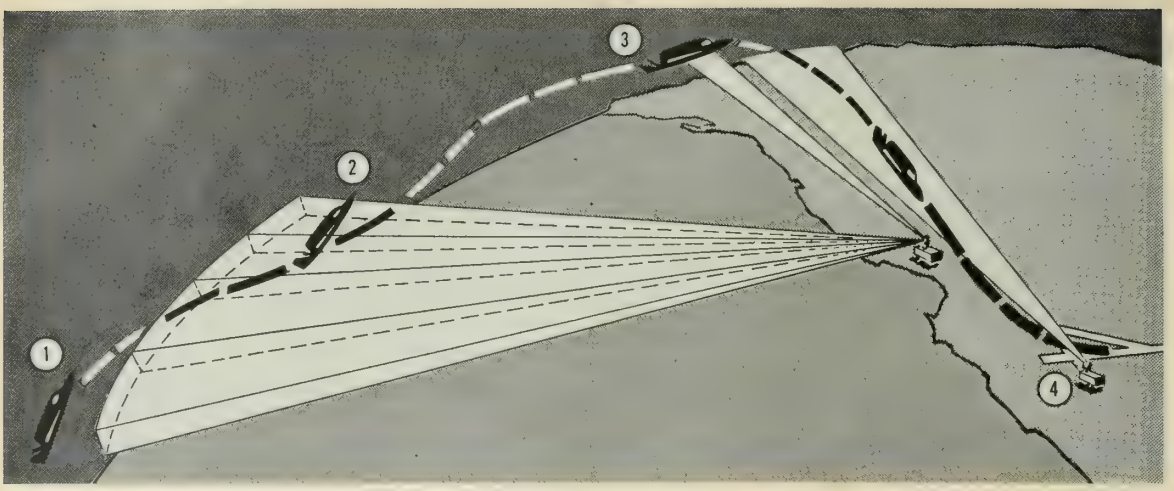
ARIS a Requirement Problem

The Advance Range Instrumentation Ship (ARIS) project will be reviewed by Air Force Systems Command at a Washington meeting Feb. 1. Rep Frank Thompson, D-N.J. disclosed this after meeting with Joseph Imrie, Asst. Air Force Secretary for Materiel on whether the $20 to $40 million contract will go to RCA's Moorestown, N.J. plant. Thompson was told the entire project is a matter of requirement, not procurement, and that RCA was as qualified as several other bidding firms. The program may be delayed because of the cutback in the *Nike-Zeus* program. The contract involves equipping a converted Navy ship with tracking equipment for use on the Atlantic Missile Range.

LIFE SCIENCES

Melpar Moves on Bio Front

Gas cromatography can be used to identify bacteria, Melpar Inc., scientists have found. Not only does each bacterium have an identifiable pattern, but chromotography will show its history—on what it grew and where it grew. Thus one sensing tool could be used to determine both elemental composition and bacterial life on other planets. Melpar investigators also found that animals and vegetables may have a built-in mechanism to predict solar flares. Research shows there is a high statistical relationship between certain biological changes and solar events—the changes occuring hours before the flares. The company expects to answer this year whether this relationship is solid enough to use in prediction.



PROFILE SHOWS RE-ENTRY, terminal control and landing of unmanned X-20A (Dyna-Soar) using Sperry Phoenix MATCON system. Pt. Arguello ground station will acquire vehicle 300-500 mi. off Pacific Coast, bring it to coastal area and "hand over" control to second landing control station at Edwards AFB.

space electronics

'MATCON' To Bring Back X-20A's

Sperry Phoenix-developed system using two ground stations and flight subsystems will be tested with drones early in '64

by Charles D. LaFond

VEHICLE RECOVERY in next year's unmanned *X-20A* airdrop and Earth-orbital flights will be accomplished through use of a new microwave ground terminal control system.

Now in the equipment design phase, the system—called MATCON for Microwave Aerospace Terminal Control—will be ready for test operation early in 1964 at Edwards Air Force Base, Calif., using jet drones.

Under development for the Air Force by Sperry Phoenix Co., a division of Sperry Rand Corp., the system will be comprised of two ground-control stations and active flight subsystems. All control will be through single X-band radar and PCM telemetry via a vehicle transponder.

Recovery with MATCON includes the remote flight control and energy management of the vehicle after re-entry through a final window, handover to a second ground-control station and safe letdown at Edwards AFB.

• **Prime requirement**—The principal design requirement is that the system must be able to acquire the *X-20A* in virtually any conceivable re-entry condition and energy-state condition, determine the correct flight profile based on these conditions, and then control the vehicle through final recovery.

In describing the *X-20A* recovery task, Max Beers, Sperry's manager of spacecraft-recovery and communications projects, stressed that energy management is the most difficult problem. In short, he said, it boils down to acquiring control of the vehicle travelling roughly 7000 mph at up to 500 miles out over the Pacific Ocean, commanding the proper approach path to expend 30 billion ft.-lbs. of energy, and steering the craft to a conventional landing.

The present *Dyna-Soar* test program, according to T. J. Keating, assistant chief of the *X-20A* engineering office at Aeronautical Systems Division, consists of four phases: B-52 airdrops, *Titan III*-launched unmanned flights, a manned single-orbit flight with minimum-risk re-entry path, single-orbit manned flights to determine actual re-entry corridor limits, and finally a variety of re-entry tests after multi-orbit flights to test subsystems and pilots.

Sperry began its preliminary system design in July, 1962, with award of a $350,000 controlled-expenditure contract from the Aeronautical Systems Div. AFSC, Wright-Patterson AFB, Ohio.

Details of a final development, installation, test and operation contract are now being negotiated, a Sperry official told MISSILES AND ROCKETS.

First flight tests employing the new system in a *QF-104* drone will begin in 13-14 months at Edwards.

According to present plans, the system will be employed operationally for the recovery of two unmanned *X-20A* orbital test vehicles. Launches will be made from the Atlantic Missile Range with the Air Force *Titan III*, the first assignment for the new space booster. Recovery will be attemped at Edwards.

Sperry officials declined to comment on follow-on assignments for the system; however, by the nature of the recovery approach it could be employed usefully as back-up for early manned flights of *Dyna-Soar*.

• **Acquisition and terminal control**—A modified AN/TPW-1 ground-control station installed in a mobile van will be situated at Point Arguello, Pacific Missile Range, 120 mi. west of

the runway at Edwards. This station will acquire the glider 400 to 500 mi. west of the coast. It will immediately verify operation of vehicle-installed recovery equipment and assess energy state of the glider.

If results of this verification and assessment are negative, the mission can be terminated at this point; otherwise the station will control the *X-20A* energy profile to achieve arrival over the coast within narrow velocity, altitude, and directional limits.

A similarly modified AN/TPW-1 ground-control station will be located adjacent to the runway at Edwards. This station will acquire the vehicle as it passes Arguello. Semi-automatic letdown and flare control functions of this station are augmented with manned override control from ground operators.

(The accompanying illustration is a functional block diagram of this station. It shows schematically the manner in which a two-way data link is superimposed on the X-band tracking radar, and how these three functions are coupled through computers and displays to provide automatic or manual glider control.)

Sets of equipment for *X-20A* installation to be fabricated include a modified AN/APW-22 transponder and an associated flight-control coupler. The transponder will complete the tracking and communications links. The flight-control coupler will convert ground-delivered command data into appropriate flight-control signals, and transform onboard derived data into a form suitable for transmission to the ground.

• **System operation**—The radar associated with the MATCON system will be needed to acquire and track the airborne transponder in the *X-20A* vehicle. The Arguello site, using a 96-in. dish antenna, must acquire the craft as soon as possible after re-entry—and with a very high probability of success.

The acquisition problem is greatly simplified, developers claim, compared to a more conventional radar system by using an airborne beacon with an identity code system, which allows angle tracking to be accomplished before range tracking. This simplifies the search problem to a two-dimensional problem—elevation and azimuth angles.

Once the target has been acquired in angle, range acquisition is then automatically performed. Also, frequency search is not necessary since the system bandwidth is sufficient to cover small drifts in the transmitter and receiver frequencies.

Ground-station equipment is based primarily around the pulse-coded X-band tracking/communications system. A combined data-link and automatic tracking system, it can transmit 63 discrete commands and receive on an eight-channel, eight-bit subsystem. Binary coded data are received from the vehicle to an accuracy of 0.5% (or one part in 256 on an eight-bit binary).

Acquisition radar beamwidth will be from 2° to 4°.

• **Transfer of control**—Transfer of control from the acquisition control center to the terminal control center will occur at a point just off the California coast. This allows 8-10 min. for first-station control. Because of the basic MATCON system configuration, transfer of control from the acquisition control center to the terminal control center will be implemented without the loss of any flight data by either station.

Before active control is relinquished at Arguello, the Edwards station acquires and parallels the complete guidance-control operation for several minutes. Actual handover requires about 20 sec. When handover is accomplished, there is no discontinuity of control.

The acquisition control center will be able to maintain flight data monitoring after control has been transferred to the terminal control center. Via voice communication, the two centers will be able to monitor and confirm the results of all communications sent, providing range safety with redundant sources of information.

Landing speed at touchdown will be about 170 knots—or comparable to today's high-speed jets. The MATCON system is designed, however, to handle landing speeds up to 200 knots.

If acquisition of the *X-20A* should be too late to satisfy rigid safety requirements for recovery, a pre-planned abort maneuver will be initiated to destroy the craft.

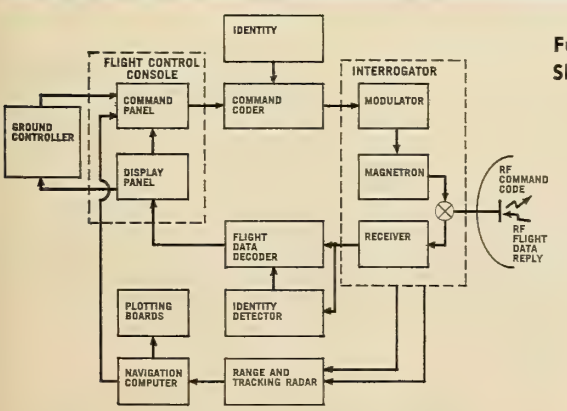
If control is firm but a safe landing is doubtful, the craft could be water ditched in a pre-assigned location. This would permit recovery of at least a portion of the vehicle for subsequent study. The decision to destroy or ditch will be the responsibility of Arguello station personnel.

Both ground stations will be jointly manned by Air Force and Sperry. Air Force recovery personnel will operate MATCON controls during actual missions; Sperry technicians will operate and service the equipment.

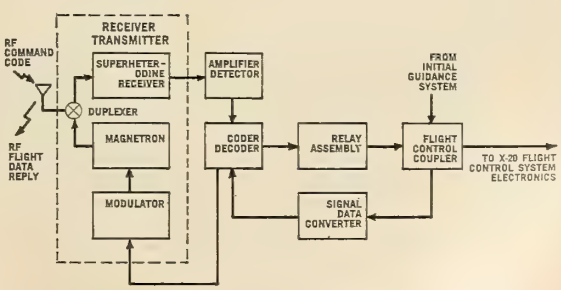
Station visual displays include a 30x30-in. initial plot board to indicate the ground track 's x-y coordinates, and a vertical-height display. Centers also are provided with conventional flight-panel indicators to assist in control.

In the early flight test program, the *QF-104* drone will be equipped to simulate the *X-20A* control configuration. It will be used for system checkout, station operator training, and pre-mission readiness checks. ⌗

Functional Block Diagram of MATCON Shows Ground Station and Flight Subsystems



BASIC GROUND TERMINAL-CONTROL STATION



X-20 FLIGHT SUBSYSTEM

Melpar Tissue Growth Holds Promise

Method may be capable of large-scale food production for astronauts on long journeys

by Heather M. David

AN AUTOMATIC TISSUE-culture laboratory that may someday turn out steaks, potatoes and oxygen-giving plant life is being developed by Melpar, Inc., Fairfax, Va.

Although the technique of growing tissues from small samples is not new, Melpar is developing automatic equipment that will make large-scale production possible. It formerly took highly trained scientists years of work to produce small amounts.

Ramifications of the system are far-reaching: Melpar scientists told MISSILES AND ROCKETS the system may:

—Produce food tissues—meat, fruit, vegetables — for astronauts on long space voyages. A continuous supply would be effected by leaving only a small amount in the equipment each time the crop was "harvested."

—Grow vegetative material for photosynthetic production of oxygen and removal of CO_2 in space capsules or in planet colonies.

—Be used for mass production of vaccines, gamma globulin, etc.

—Grow skin and other tissue for regrafting on injured patients from small samples of their own tissue.

—Grow corneas and other tissue that can be transplanted.

• **Shortcuts explained**—The technique of tissue culture essentially bypasses the whole body or plant stage, by giving the tissue sample all the nutrients and growing conditions the body did. The nutrient that nourishes it is comprised of more than 90 organic substances, the same that the body or plant provides. Thus food produced in the laboratory would taste the same as its natural source.

An advantage of the system for space use is that it requires little room. The tomato can be grown without the leaves, branches and roots; pork chops produced without the pig.

The food could be produced in any size or shape desired. For instance, T-bone steak would be boneless, could be packaged as a meatball or sausage.

Taste, mineral and vitamin value and tenderness also could be controlled simply by putting the proportion desired into the original sample.

Actually, production of foods will be a simple matter when the technique of culturing single tissues is mastered.

Melpar began the program just a year ago, and in two more years expects to have significant results. The company's ultimate goal is to produce thousands of gallons of tissue on an essentially closed-loop operation.

The process falls into five steps:

1. A sample of tissue desired is taken.

2. Pipetting—measured amounts of nutrient and tissue are injected into a sealed tube in the laboratory.

3. The tissue grows. Tissues grow at different rates, and then often grow differently outside the body. The laboratory, since it is automatically controlled, will be an excellent research tool to investigate what affects these rates.

4. Monitoring growth—Throughout the process, there is an automatic readout that controls each step. It also provides feedback comparing the end product with the original sample to insure that they are the same.

5. Material is harvested from the media, passing through tubes from the sealed containers into a collection device. Melpar's current prototype has a vibration device that separates tissue particles by size, and also has an automatic refrigeration device.

• **Completely controlled**—Melpar's laboratory is a clean-room operation in which temperature, humidity and light are automatically controlled for various growth rates and cycles. Presumably, these growth rates can be manipulated for increased production.

Essential to the production unit is a preparation laboratory also designed by Melpar scientists. It is a completely enclosed plexiglass laboratory workbench, upon which the scientist works by using rubber gloves built through the walls. Since the glove entrances are sealed to the walls, no contaminating entry is made into the chamber.

• **Sky's the limit**—The theoretical possibilities of the tissue-culture system are endless. In theory, any function carried on by tissue in the body could be selected and emphasized.

For instance, the automatic laboratory could be controlled to stimulate hormone-producing tissue—making possible large-scale production. Plant tissue could be selected to bear useful products only—for example, rubber tissue would produce only the sap.

Patent procedures are now being worked out. Weightlessness experiments will be conducted shortly. ⌘



. . . and Leave The Tracking To Us

THREE MOBILE tracking stations for use in "classified" Air Force projects are being operated by Lockheed Missiles and Space Co. One is based at Vandenberg AFB, and at least one of the others is reported to be working in Hawaii. Built by Crown Coach Corp., Los Angeles, the units can carry a 10,000-lb. payload up a 20% grade, and can operate sideslant on slopes of up to 25%.

DROPOUT PROTECTION



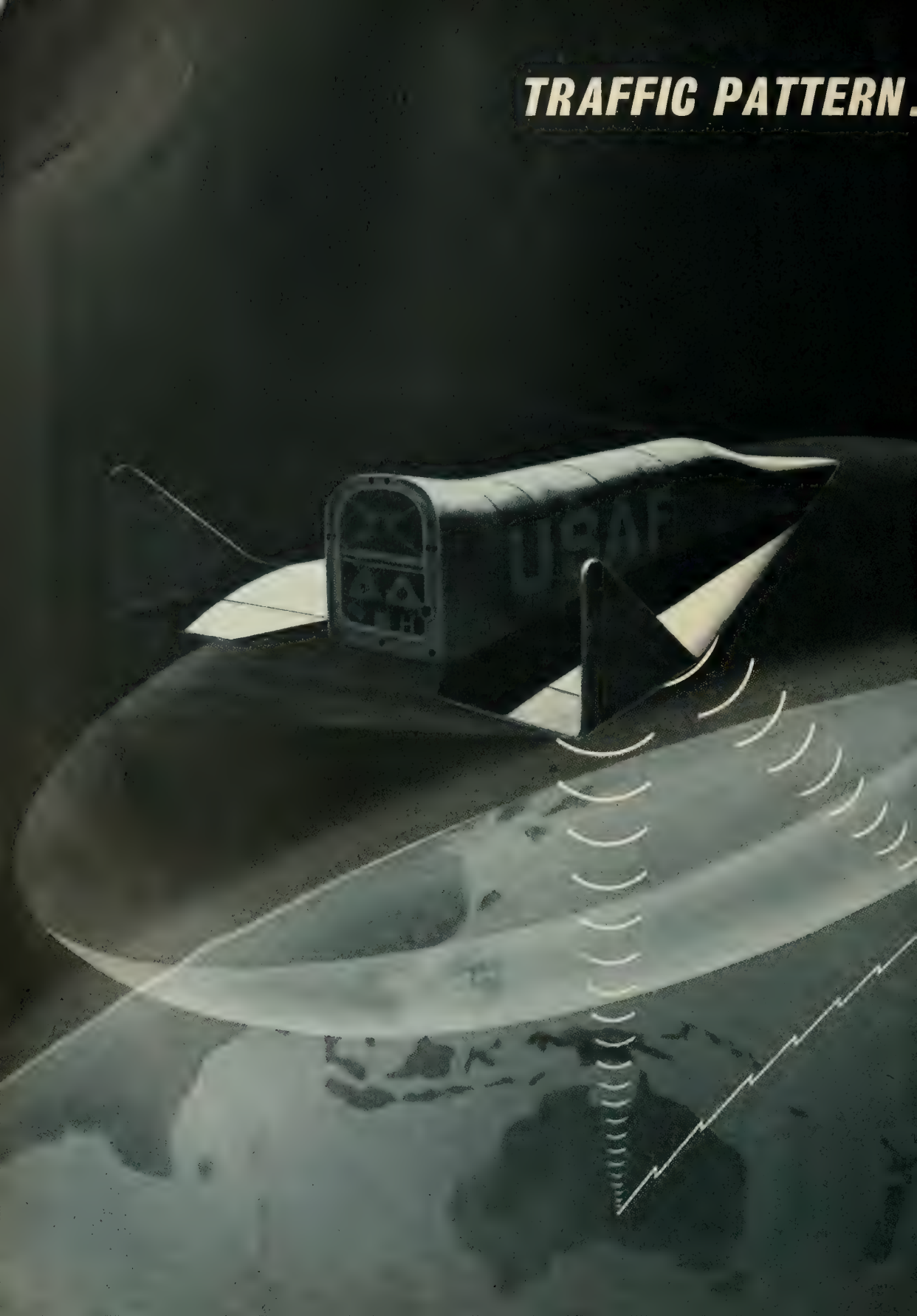
MINCOM SERIES CM-100 RECORDER / REPRODUCER

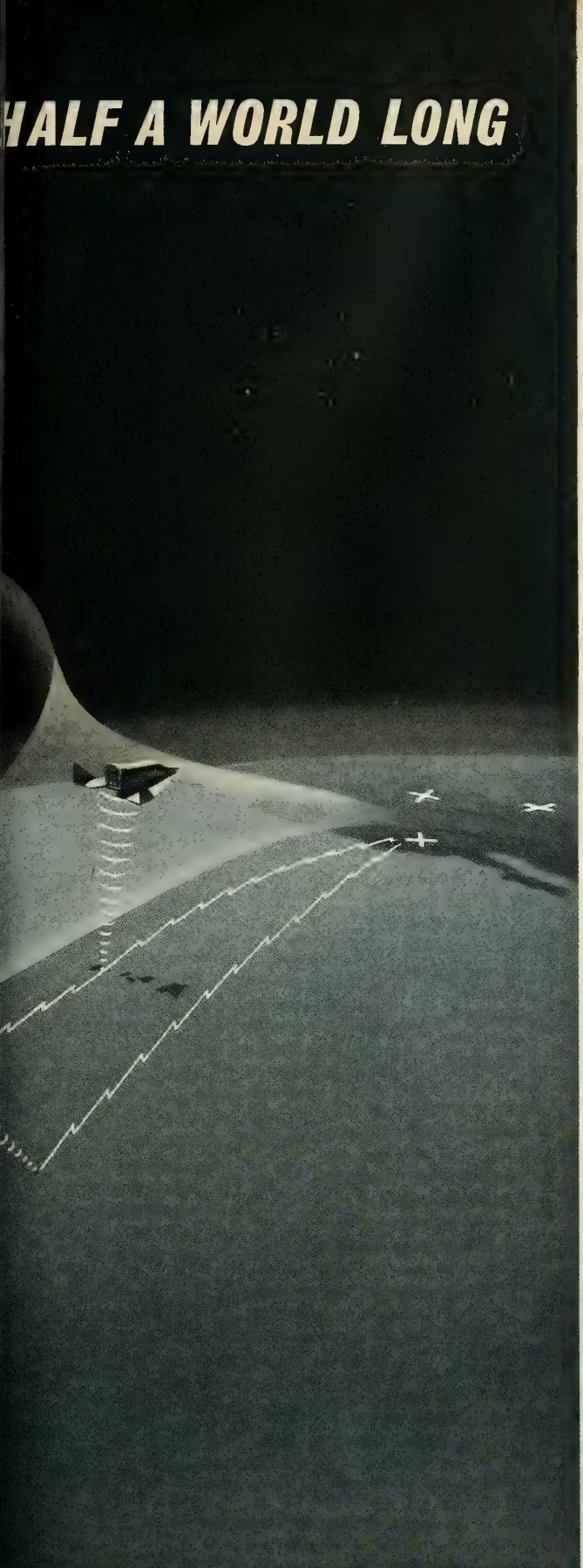
Data loss from dropouts is practically eliminated in the CM-100, due to this unique system's predetection recording capability. In ordinary post-recording, a dropout more than 6 db down is generally considered a data loss; the CM-100's operational predetection performance retains such signals through superior phase characteristics and extended bandwidth. **Mincom's CM-100 Recorder/Reproducer,** performing longitudinal recording with fixed heads up to 1.5 mc at 120 ips, also offers 7 or 14 tracks, trouble-free dynamic braking, complete modular plug-in assembly, built-in calibration, instant push-button selection of six speeds. Versatile, reliable, a model of simple maintenance and operation, the CM-100 is tops in its field. Write today for detailed specifications.

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TRAFFIC PATTERN.
USAF



The Problem . . . Space Vehicle Recovery

How do you guide a manned, maneuverable re-entry vehicle to a routine landing . . . from 200 miles up, 10,000 miles out?

What are the basic system requirements, the operational concepts of a Recovery Control Center? What limits and tolerances will exist for each stage of the recovery process (re-entry, hypersonic flight, terminal approach, etc.)? What are the flight parameters, the human factors? What is needed in the way of vehicle energy management, ground guidance, range instrumentation, data processing, data handling, display, communications, trajectory analysis, information flow analysis?

For over three years a Raytheon team led by R. L. Schroeder and John Zvara has been investigating these and other recovery problems. Primary emphasis has been placed on NASA's Gemini and Apollo, USAF's X-20 (Dyna-Soar), SLOMAR, and recoverable booster programs.

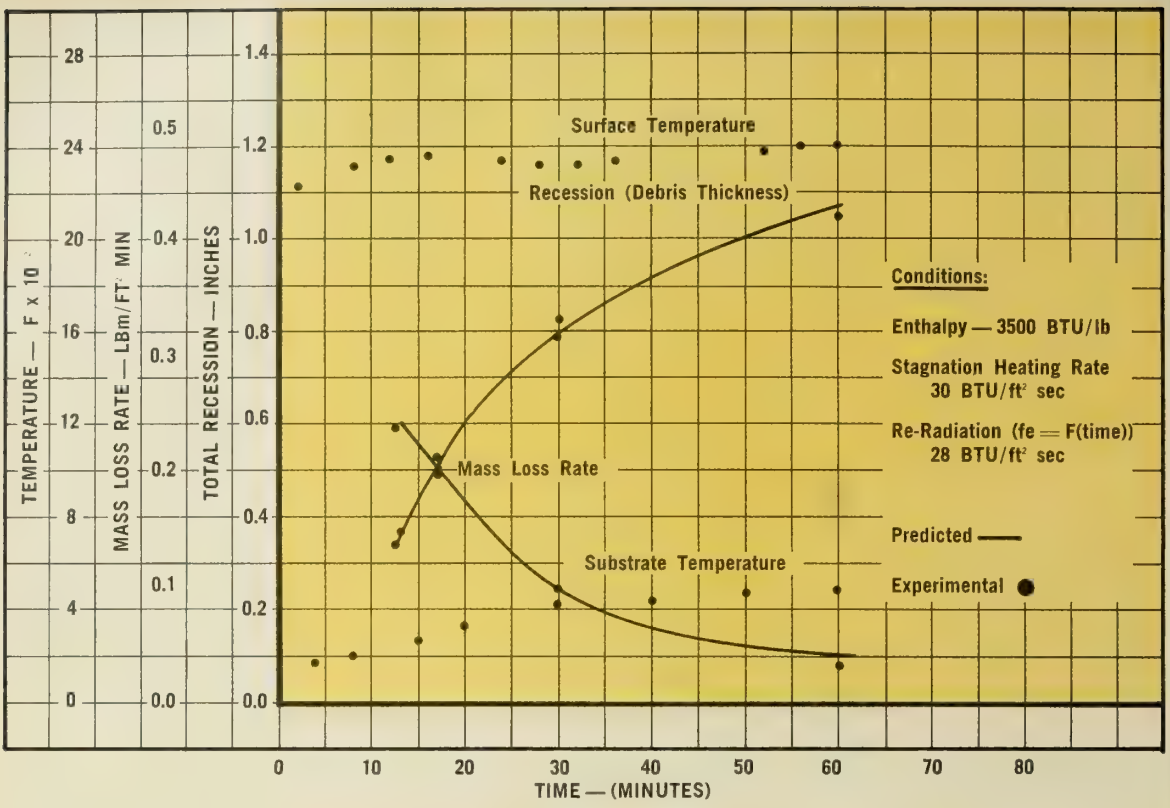
Result: A unique conceptual techniques capability. Understanding of what must be done to make a Recovery Control System work. Allied experience in real-time data processing and display, communications, and hypersonic vehicle guidance.

Schroeder, Zvara and other Raytheon scientists have published many technical articles on recovery control requirements, problems and concepts. We have collected a number of these and bound them under a single cover. If you would like a copy of this comprehensive document on system requirements for manned space vehicle recovery, write: M. B. Curran, Dept. GM 13-6A, Raytheon Co., Lexington 73, Massachusetts.



Raytheon's John Zvara (left) and R. L. Schroeder

RAYTHEON



MASS-LOSS CURVE vs. time strikingly illustrates built-in reliability of Thermo-Lag formulations. Should an object deviate in trajectory and experience six times intended heat pulse, only twice the original design thickness of sublimate is needed.

advanced materials

Emerson Seeks Bigger Re-entry Role

Firm employs sublimating formulations and customized approach to temperature control

by John F. Judge

A FAMILY OF sublimating formulations and a customized approach to temperature control problems may boost Emerson Electric into a prime position in re-entry and other aerospace thermal-protection market areas.

The firm's proprietary compounds already are being evaluated with primary thermal shielding in super-orbital re-entry applications in mind.

Trademarked "Thermo-Lag," the compositions are being used in *Scout, Thor, Thor-Delta* and *Polaris*, and in sections of the *Saturn C-1*, as well as a host of other rocket programs.

By customized thermostatic temperature control, Emerson means that, given a structure with a maximum allowable temperature limit, the firm will design a material guaranteeing this temperature.

If a structural member must function in a high-temperature environment for a definite period, a Thermo-Lag composition can be especially designed to protect the member from reaching strength-degrading temperatures.

Rubin Feldman, head of Emerson's new thermal chemistry facility and the inventor of Thermo-Lag, says this thermostatic control is a proved capability, backed by successful operational use and telemetered data. There also is a wealth of test information from various sources such as the University of Chicago and Plasmadyne Corp., he said.

Essentially, Thermo-Lag provides thermostatic temperature control through the sublimation of inorganic compositions. But the total thermal protecting and heat controlling effect of the compositions is much greater than that expected from mere utilization of the latent heat of sublimation.

• **Solid-to-gas**—In the process of sublimation as it is usually defined, a solid is changed into vapor without

B.F.Goodrich

aerospace and defense products

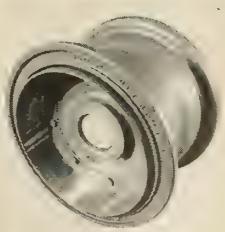


14-pound magnesium wheels carry heavyweight missile

The Army's Pershing missile system is planned for maximum mobility. Thus, the missile's Erector-Launcher unit, equipped with BFG wheels, is designed to be air transportable.

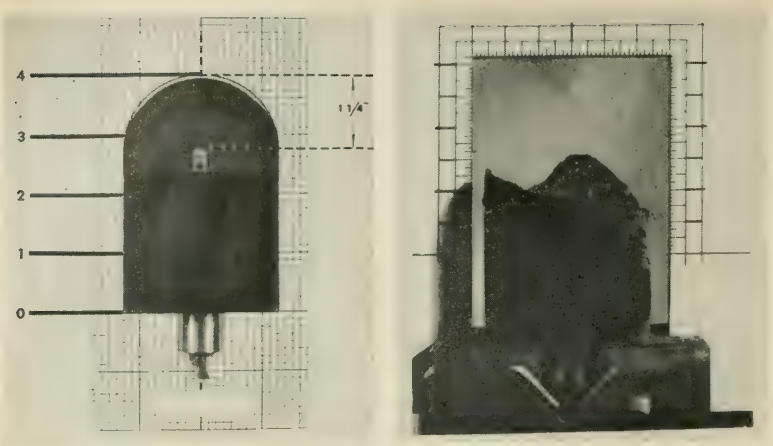
With both high strength and low weight important, BFG cast magnesium wheels were selected. The wheel weighs only 14 pounds (compared to a steel stamping originally considered of 39 pounds). Each wheel weighs but half as much as its tire! Yet each wheel is rated for 6000 pounds, and in tests withstands 26,600 pounds ultimate on the axle.

To save weight on air transportable vehicles, draw on the long experience of BFG in producing aircraft wheels in light metals. This can solve your strength/weight problem. For information contact *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Dept. MR-1, Troy, Ohio.*



Wheels for air transportable Erector-Launcher, built by Unidynamics, a division of Universal Match Corporation.

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THERMO-LAG sample exposed to plasma jet (left) retained its essential configuration in building "char" layer, while phenoli-nylon sample (right) disappeared.

going through the liquid state. Generally, a subliming substance remains at a constant temperature until the process is completed.

In the Thermo-Lag compositions, the latent heat of sublimation—in combination with thermal diffusivity, mass transfer, an increase of the boundary layer with the low molecular weight gases, and further sublimate dissociation in the solid debris layer (inorganic "char")—acts as a heat blocker.

Thermo-Lag materials sublime at predesigned, fixed temperatures—limiting the temperature of any substrate to a known maximum. As the material sublimes, the products of decomposition of certain additives form a stable debris layer. This relatively rugged debris layer is capable of achieving a high surface temperature through which the subliming gases transpire.

It is also possible to vary the surface emissivity by carefully choosing formulation ingredients. All other physical and thermodynamic properties remain basically unchanged. Since the temperature of sublimation is not a function of the rate and quantity of heat input, Feldman says, Thermo-Lag is superior in this respect to current ablative processes.

• **Mechanism of protection**—There are five distinct but interrelated blocking mechanisms provided by a Thermo-Lag coating. The first is sublimation. As this occurs, a stable debris layer forms on the virgin Thermo-Lag surface. This inorganic "char" layer, combined with unaffected coating, serves as an insulator.

As the subliming gases pass through the debris layer, their dissociation absorbs additional heat. The same passage effects transpiration cooling. Finally, external radiation is a factor because of the high temperatures reached at the surface of the debris layer.

Temperature control is positive, says Feldman, because the materials sublime within ±10°F of the design temperature. Thermo-Lag has a high resistance to thermal shock and there is no cracking or spalling under severe or unusual thermal conditions.

Its mechanical shock properties are fairly good, as evidenced by the recovery of an intact coating on an *Honest John* nozzle after an impact force totalling several thousand g's.

All of these points are cited by Emerson to back up the predictable and reliable results achieved with the high temperature coating.

In the weight-saving category, Thermo-Lag compositions start with low quantities because of the high heat absorption properties. In addition, the sublimation factor means a decrease in weight as heat is applied. Ideally, there should be no coating left after the heat period.

The coated structure can be built lighter by thus avoiding safety factors for excess heating. Also, Thermo-Lag can be machined easily to remove any excess before the actual use of a structure.

Mixed and applied like paint by use of conventional spraying, brushing or dipping equipment, the substances cure at temperatures ranging from ambient to 280°F. Some Thermo-Lag formulas are manufactured in powder form—a more suitable state for molding operations.

The compositions have been successfully applied to steel, aluminum, magnesium, copper, molybdenum, titanium and various polyester, phenolic and epoxy laminates. The material bonds well to clean surfaces.

• **Infiltrate methods**—The Emerson process is not limited to coating applications. Porous materials can be impregnated with the sublimating compositions. Thermo-Lag formulations can be forced into the pores of such materials in the gaseous state and deposited through condensation.

A related form of impregnation can be used in the fabrication of laminated structures. Glass-fiber cloth, for example, can be saturated with a solution of sublimate, and evaporation leaves the solid material deposited at the interstices of the cloth. The cloth can either be used as is or laminated with other materials.

Sublimating compositions may be incorporated into refractories by mixing the two together with a suitable binder. Shapes can be formed from the mixture by curing at heats less than the subliming temperature.

Emerson also is working on mastics of the compositions for applications in honeycombs, where loads are a factor.

The thickness of the Thermo-Lag coating determines the length of time the coating will be effective at a given temperature of sublimation. Thick coatings pose no particular problems when applied to the flame or hot side of the structure to be protected, since sublimation occurs at the outer (exposed) surface.

But if the coating is on the shielded side of a structure, a porous or patterned coat must be used or a conductive material extending into or through the coat must be provided.

Thermo-Lag compounds under development cover the sublimation range from 160°F to 2200°F, though higher and lower temperature control ranges have been considered and are deemed realistic. Representative inorganic sublimating compounds include chromium trichloride, mercuric sulfide, phosphorous pentoxide, ammonium, chloride, molybdenum hexacarbonyl, ammonium fluoroborate, molybdenum oxide, iodine bromide, ammonium sulfite, ammonium thiosulfate, nitrogen sulfide, phosphorous pentachloride, phosphorous tetraoxide, mercurous bromide, selenium dioxide, potassium amide, mercuric sulfite, beryllium bromide and ammonium iodide.

These compounds are dissolved in a variety of solvents such as propanol, isopropanol, ethyl alcohol, etc. The only limitation here is that the solvents must be unreactive with the rest of the ingredients and, preferably, non-toxic. The amount involved, the viscosity and the boiling point are determined by the end use of the particular formulation. Of course the solvents must evaporate below the formulation's operating temperature.

Resin content and type is similarly determined if the formulation calls for binders. Phenol-formaldehyde is a typical thermosetting resin used in high temperature formulations while lower sublimates may involve resorcinal-phenol-formaldehyde, for example. ⌘

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Hound Dog Hydraulics Spur Innovation

American Brake's Aerospace Div. proposes pumps for space-limited applications

by G. V. Pesce
Regional Manager, Aerospace Div.
American Brake Shoe Co.
Oxnard, Calif.

A SERIES OF hydraulic pumps, based on thru-shaft type design, is being proposed by American Brake Shoe Co.'s Aerospace Div. for applications in which space limitations dictate high rotating speeds and large power requirements.

The design innovation paves the way to large displacement pumps running at relatively high speeds through the stacking of small rotating groups on a single shaft and resulted from the problems encountered in developing the hydraulic pump for the Air Force's *Hound Dog* missile.

In fact, the component design actually involved three separate improvements in the state-of-the-art in airborne hydraulic pumps.

Hound Dog uses the J-52 engine, and the pump is mounted on what was normally intended as the engine starter pad. Since the intention was to carry the missile aloft under the wings of a B-52 bomber, the engine was to be started with ram air against the intake while in flight—thus making it possible to use the starter pad for the pump drive.

The hydraulic requirements for the missile were such that a 0.9-cu.-in./rev. pump was needed. But the maximum pad speed of 7300 rpm was considerably above the rated range of any available pump of that size. To cope with this requirement, the division modified its basic pump design to produce a unit capable of operating 500 hrs. with the desired capacity at temperatures in the vicinity of 275°F. The prototype of this model pump was delivered, tested, and found to meet the basic requirements.

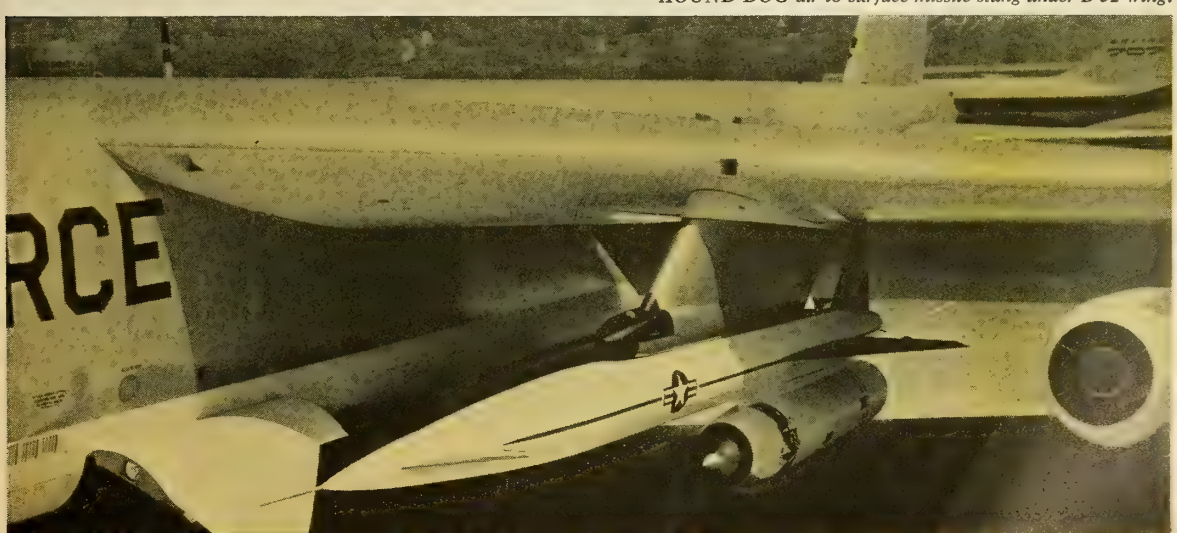
At this point in the missile's development, it became evident that sufficient space was not available to accommodate a drain line from the pump to the reservoir for the normal cooling flow circulation. At first glance, the problem of eliminating this did not appear overwhelming, since the normal missile duty cycle did not call for a complete shutoff of the pump output flow. There was always to be sufficient flow through the pump to provide a vehicle to remove the generated heat from the pump to the heat exchanger in the return line to the reservoir.

But there were portions of the case in which oil did not circulate. Accumulation of heat in these areas could not be dissipated by the normal flow through the pumping chambers of the pump. To overcome this problem, a secondary circulatory system had to be included in the pump which took a portion of the base flow and circulated it through the case and back into the primary circuit. The inclusion of this feature resulted in a unit which met all the requirements and was installed on the initial production of the *Hound Dog* missile.

• **The long slow curve**—The Air Force then decided to add ground-start ability to the *Hound Dog*. This would permit missile checkout and provide added thrust to assist the B-52 to take off with a heavy load. However, early design decisions which relegated the starter pad to be used for a pump drive deprived the missile of the only possible place for the starter to be mounted.

Pump design was then modified to run the shaft all the way through, providing for a starter which could be mounted out board of the pump and drive the engine through the pump's shaft. This technique of design not only solved the particular problem at hand, but also allowed stacking of pump rotating groups on one shaft to obtain greater displacement without increasing the pump's diameter and paying the

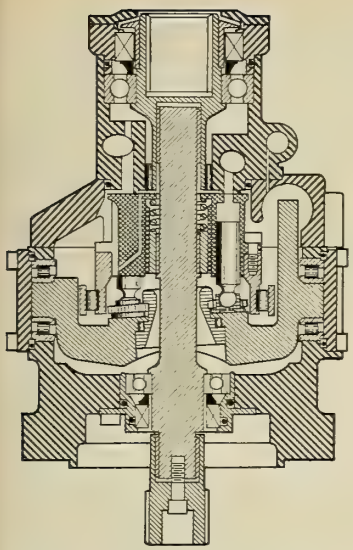
HOUND-DOG air-to-surface missile slung under B-52 wing.



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closing date/March 4/issue date/March 25, 1963



CUTAWAY VIEW shows center plunge design developed by American Brake Shoe.

penalty of reduced operating speed.

• **Speed vis-a-vis displacement**—For a pump of a particular size, maximum operating speed is limited to but three basic factors:

—Maximum rubbing velocity between mating parts, condsidering the loading.

—Head loss at inlet caused by the rate of flow through the port openings.

—Centrifugal forces developed by rotational speed.

For rotary machinery of the size (diameter) and speed range under consideration here, the centrifugal effects are not critical: rubbing velocity and head loss usually limit the speed to a value far below that at which the centrifugal forces become troublesome.

Maximum allowable rubbing velocity between two mating pieces depends somewhat on the loading between these members on the materials of which they are made, and on the lubrication which they receive. Temperature also plays an important part here, as lubricity of the more common hydraulic fluids deteriorates rapidly above 250°F.

Short of a radical change in design concept, material content or fluid medium, the only avenue left to increase the operating speed rating conveniently is to work on a reduction of loads between mating members and improving the lubrication.

By optimum use of the principle of hydraulic balance, the design makes possible better lubrication and supports the moving parts so that contact or rubbing loads are materially reduced.

As far as inlet loss is concerned, a certain degree of streamlining can be done to minimize the losses and thereby



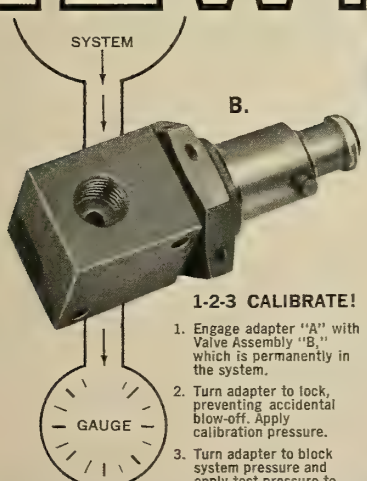
COMPLETED thru-shaft Hound Dog pump illustrates final compact configuration.

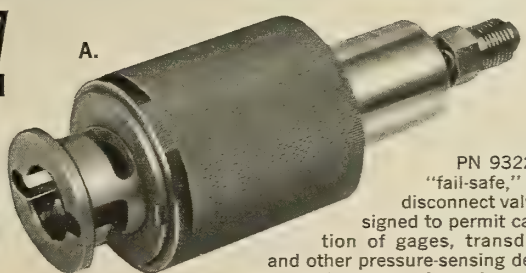
increase the flow at which this factor becomes critical. In a positive displacement pump, this increase in flow represents a proportionate increase in speed.

Also, an increase in inlet or reservoir pressurization, if possible, can satisfactorily circumvent this speed limiting condition. For this application, American's initial prototype units made

ON MARK High-Pressure Calibration Valve

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PN 9322 is a "fail-safe," quick disconnect valve designed to permit calibration of gages, transducers and other pressure-sensing devices without their removal from the system. The valve is built to withstand the extremely high pressures found in missile fluid systems, and has built-in protection for the operator against accidental "blow-off." Use of PN 9322 eliminates the necessity of shutting down and bleeding the system, removal of the gage, laboratory calibration, LOX cleaning and re-assembly, formerly required in the calibration process. It also prevents stored fluid loss as well as contamination due to disassembly.

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OPERATIONS RESEARCH to establish requirements and missions for advanced space studies.

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use of port improvement, optimum pressure balance, and improved lubrication to achieve a pump design of this displacement with a 500-hour-life rating at 7300 rpm and 275°F.

• **Thermal considerations**—Until the day when a machine with an efficiency of 100% can be achieved, all machines will generate heat. Hydraulic machinery is no exception—since the heat is generated at the pump, some means must be provided there for its removal.

Normally, in variable displacement pumps of this type, the leakage of fluid in the rotating or pumping mechanism is collected in the case and ported by a separate line through a heat exchanger and back to the reservoir. This technique is used because in most variable displacement pump applications, there are times when the outlet flow is completely cut off. With no outlet flow there can be no flow through the unit, and hence no way of dissipating the heat generated by friction, windage, and other energy losses incurred in keeping the pump running. Space limitations for this application made it virtually impossible to provide a separate case drain line.

Since the hydraulic system did not require any duty cycle that calls for a full cutoff of flow, it was decided to eliminate the case drain line, to port the internal leakage back into the inlet port, and to put the heat exchanger in the system return line. The base flow proved more than adequate for removing generated heat from the rotating or pump mechanism. However, in a portion of the pump case in the vicinity of the drive shaft and isolated from the inlet and output ports, no circulation of fluid occurred. As running continued, this more or less stagnant pocket became hotter and hotter.

To eliminate this problem, a unique secondary circulating system was devised. The potential centrifugal pumping forces available by virtue of the rotating barrel were used to pump oil from the inlet port through the case and back into the inlet port.

The Pitot tube was employed so that the inertial of the fluid in this inlet line could be used to provide a stagnation head assisting the centrifugal pump in providing sufficient head to push the fluid from the case back into the inlet line. An added assist is obtained from location of the point of re-entry downstream from the Pitot tube when the pressure is lower due to line losses and the dynamic effects of the obstruction is caused by the Pitot tube.

The addition of the centrifugal pump actually reduced the losses and improved the overall efficiency of the pump. Additional pumping losses may well be developed by the centrifugal pump, but the outlet from this pump jetting into the case causes the case oil to rotate in the same direction as the rotating parts—thereby causing an apparent reduction in the windage losses.

As the case oil is kept cooler, lubricity is maintained, thereby reducing friction and windage losses. The net result seems to be that reduction in friction and windage losses slightly exceeds the small additional pumping losses.

In this case, space limitations precluded any other location for an engine starter motor, and access to this pad was blocked by the pump—so we went through the pump's center to provide access from the starter motor to the engine drive pad.

This created problems. The torque required by the starter engine starting was roughly 10 times that required to operate the pump. A material had to be selected that would make possible a shaft design capable of carrying the load and fitting in the pump without increasing its diameter and reducing its maximum allowable speed.

Another problem of somewhat lesser magnitude involved provision for an additional shaft seal, and the means to conduct the seepage from this seal to the drain boss at the mounting flange end of the pump. This detail was achieved by the slinger type arrangement shown in the cutaway, which appears on page 45.

The dividend in the situation is in the form of a breakthrough that makes possible a speed rating at the high level of the small rotating group, and yet enables large displacements all in one package—with the consequential saving in space and weight.

The *Hound Dog* application illustrates the flexibility of the approach in meeting design changes, but the system can be used in any application where space is critical and an extremely large pump would be needed to meet requirements.

The system can also be used as a motor, and was proposed as such in a bid for part of a recent hydrofoil landing vehicle. The approach can be used when total system capacity is required from one unit to cut diameter of the pump component and reduce the problems usually tied to the high perimeter speed of large diameter pumps.

Two or more pumps can be placed on the same shaft for redundancy, each with its own fluid supply. The stacked concept permits use of stronger shafts plus shear sections assuring hydraulic pressure continuance in case of a single pump failure. ⌘

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FY '64 construction funds . . .

NASA Seeking First Big Money For Mississippi

NASA's Mississippi Test Facility will get its first heavy funding if Congress approves the space agency's Fiscal '64 budget request.

About $111 million will be spent to develop the facility —$35.9 million of the total for test stands for the *Advanced Saturn* first stage and $19.1 million for test facilities for the big booster's second stage.

The figures were shown in a NASA budget breakdown. Some details not included in the accompanying table:

Various Locations—The $176-million total includes $90 million for three new tracking ships for the *Gemini* program and $21 million for three new tracking ships. Other facilities to be built at contractor plants include $14.2 million for the F-1 engine program, $1.5 million for H-1 engine production facilities, $6.9 million for the J-2 engine, $16 million for the M-1 engine, and $5.3 million for the *S-IVB* stage program.

Ames Research Center—Administrative management building, $1.3 million; life sciences research laboratory, $4.8 million; space environment research facility, $3.6 million; satellite attitude control systems test facility, $1.2 million; and structural dynamics laboratory, $1.6 million—a total of $13 million.

Goddard Space Flight Center—Data interpretation laboratory, $5.3 million; mechanical test facility, $5.7 million; meteorological systems development laboratory, $4.1 million; and modernization of payload test facility, $2.5 million. Other small projects bring the total to $20.9 million.

Major NASA Building Requests

(In thousands of dollars)

LAUNCH OPERATIONS CENTER:	
Advanced Saturn launch complex No. 39	217,219
Advanced Saturn supporting facilities	9,309
Barge lock and channel	1,000
Cafeteria	899
Calibrations and standards laboratory	2,867
Central instrumentation facility	31,508
Deep space network launch station	4,000
Launch equipment shop	1,517
Manned spacecraft facilities	6,512
Modifications to Saturn launch complex No. 34	1,310
Modifications to Saturn launch complex No. 37	3,435
Optical and electronic component servicing facility	855
Range engineering and administration building	605
Range instrumentation sites	4,823
Unmanned satellite operations facility	1,680
Utility installations—New Area	23,755
Vehicle maintenance and service facilities	1,561
Total	312,855
LEWIS RESEARCH CENTER:	
Addition to the spacecraft propulsion research facility (Plum Brook Station)	3,500
Alteration of the space power chambers	5,665

(Continued on p. 50)



THE FLEXIBLE MEN Never has man faced so formidable a combination of unknowns as in the exploration of space. It is a challenge that demands investigation along the entire spectrum of the scientific disciplines; it represents a compendium of scientific thought that is being revised and refined hour by hour...by men of widely diverse scientific backgrounds.

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They are the flexible men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

Electric power equipment test facility	2,100
Engineering building (Plum Brook Station)	1,710
Experiment assembly, test, and storage building (Plum Brook Station)	885
Modernization of the instrument research laboratory	2,002
Propellant flow systems facility (Plum Brook Station)	1,316
Propulsion component evaluation facility	1,004
SNAP-8 assembly and spacecraft checkout building (Plum Brook Station)	5,000
Zero gravity facility	2,653
Total	**25,835**

MANNED SPACECRAFT CENTER:

Additions to the mission control center	8,409
Atmospheric re-entry materials and structures evaluation facilities	2,915
Center support facilities	5,162
Launch environment and antennae test facilities	7,482
Mission simulation and training facility	2,216
Project engineering facility	2,761
Spacecraft control technology laboratory	6,106
Ultra-high vacuum space chamber facility	2,685
Total	**37,736**

MARSHALL SPACE FLIGHT CENTER:

Acceleration test and calibration facility	1,700
Acoustic model test facility	2,000
Additions to the components test facilities	3,875
Addition to the test support shop	1,500
Barge dock and loading facilities	800
Expansion and modernization of the high pressure gas and propellant systems	4,000
Expansion of computation facilities	2,315
Extension to the load test annex	3,656
Extension to the propulsion and vehicle engineering laboratory	1,900
Hangar for vehicle components	2,800
Modernization of instrumentation and control systems in the east area	3,500
Hazardous operations laboratory	500
Modification to the vehicle assembly building	1,800
Project engineer office	2,650
Support operations building	500
Utility installations	5,000
Total	**38,496**

MISSISSIPPI TEST FACILITY:

Advanced Saturn first stage (S-IC) static test facilities	35,983
Advanced Saturn second stage (S-II) static test facilities	19,148
Bridge for U.S. Interstate Highway No. 10	4,500
Control center and data acquisition and handling facilities	4,613
Electronic, instrumentation and materials laboratory	2,716
F-1 engine systems test stand	9,000
Maintenance facilities	5,987
Navigation lock	6,604
Security control facilities	675
Sonic measuring facilities	1,760
Transportation and parking facilities	7,585
Utility additions and extensions	6,559
Warehouse addition and storage facilities	2,318
Waterways and docking facilities	4,242
Total	**111,690**

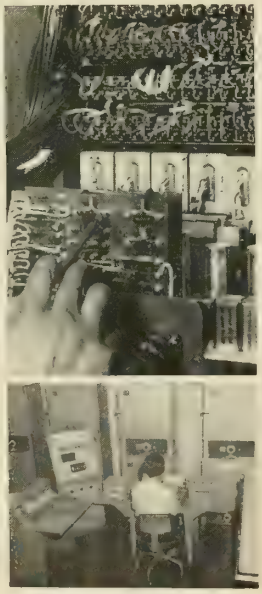
OTHER CENTERS:

Ames Research Center	13,076
Flight Research Center	4,081
Goddard Space Flight Center	20,932
Jet Propulsion Laboratory	7,000
Langley Research Center	9,768
Michoud Plant	10,003
Nuclear Rocket Development Station	20,490
Wallops Station	2,000
Total	**87,350**

VARIOUS LOCATIONS:	**176,838**
FACILITY PLANNING AND DESIGN:	**10,000**
TOTAL PROGRAM	**800,000**

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Scientists and Engineers, too, Look to Lockheed for Leadership





INSTANT LAUNCH

Will space vehicles of the future be launched on a ready-set-go basis? "Yes," says Robert A. Bailey, chief spacecraft engineer of Lockheed-California.

"Refinement of current launch procedures is inevitable in the years ahead if we are to achieve greater efficiency for America's space assault. New techniques in spacecraft launching are essential if we are to rendezvous with manned space-based vehicles."

As visualized by Lockheed-California scientists, automatic launching of "flight ready" probes depends on completing a maximum number of pre-flight operations before the spacecraft moves to its launching pad. Mating, assembly, tests and erection would be performed off the launch site. Result? Between-firing periods would be cut to hours instead of days or weeks.

This new concept in spacecraft and missile launchings — rapid-fire liftoffs that meet selected, split-second schedules — typifies the challenging problems that engross the attention of those who work here.

SCIENTISTS AND ENGINEERS of top-level talent and training are invited to explore the immediate openings at Lockheed-California in: Antennas and Propagation; Advanced Systems Planning; Bioastronautics and Space Medicine; RF Equipment; Astrophysics; Communications Analysis; Aerophysics; Tracing, Telemetry, Command Engineering; Weapons Effects; Operations Research; Theoretical Physics; Radar Systems; Dynamics (Flutter, Aeroelasticity); Thermodynamics; Flight Test; Guidance and Control.

Write: Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1701, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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What name is on the first 1.5 Mc recorder? **AMPEX**

Here it is: a 1.5 Mc per track, multi-track recorder! And Ampex is the first to have it. It's called the FR-1400. It will give you the broadest bandwidth yet in longitudinal recording. What's more, it utilizes solid state electronics throughout—all in one rack. It has four speeds, each electrically switchable with no adjustments needed. And it comes with tape search and shuttle to provide quick data location and permit any portion of the tape to run repeatedly without operator attention. What about performance? Outstanding! It offers better rise time and minimum ringing on square waves, low intermodulation distortion, and improved flutter. Ampex also brings you a new 1.5 Mc tape. In both you'll find the same engineering precision, the same superior quality, that has made Ampex first in the field of magnetic recording. Write the only company providing recorders and tape for every application: Ampex Corp., 934 Charter St., Redwood City, Calif. Worldwide sales and service. AMPEX



Circle No. 13 on Subscriber Service Card

Martin Names New VP's

Martin Co. has announced appointment of four new vice presidents—three promoted from within the firm and one appointed from outside the company.

Vernon R. Rawlings, former manager of site activation for *Titans I* and *II* and a Martin employee for 23 years, will be vice president and general manager of a new manufacturing division within the Middle River Complex. This is the firm's seventh operating division—the fourth in the Baltimore area.

O. E. (Pat) Tibbs, a veteran test pilot, becomes vice president and general manager of Canaveral Div., Martin's flight-test arm at Cape Canaveral. Tibbs has headed the division since 1960. Before that he was chief of *Titan* activation and director of the firm's European operations.

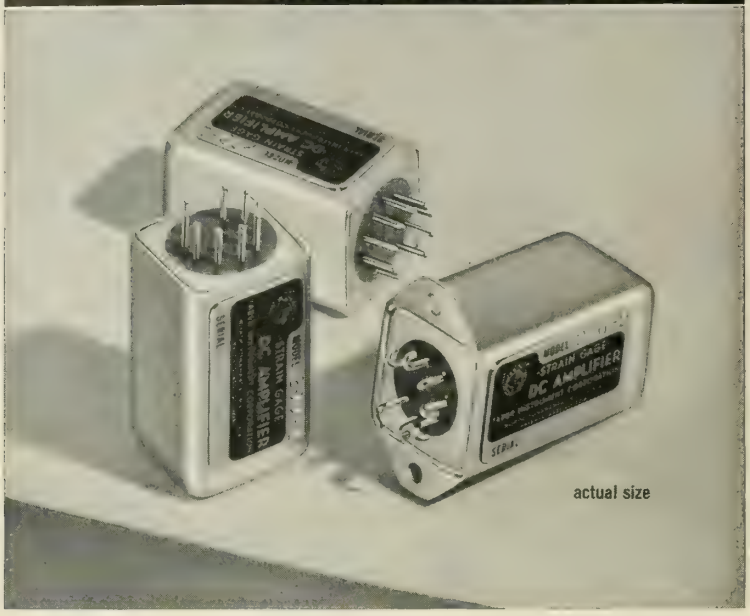
Woodrow W. Storey, previously director of contracts at the Orlando Div., is now vice president for contract administration at Friendship Headquarters, outside Baltimore. Storey replaces Paul A. Johnston, recently appointed to the firm's New York corporate staff.

Thomas G. Pownall, new vice president for sales and requirements on the Friendship executive staff, joins Martin from Fairbanks, Morse & Co., where he was vice president in charge of the company's Washington activities. He replaces Jess W. Sweetser, who became a vice president of the parent Martin Marietta Corp. last November.

Industry Facilities

Fairchild Stratos Corp. will move its Electronic Systems Div. from Long Island, N.Y., to a new branch plant to be established at Bladensburg, Md. The new facility will complete design work and produce electronic stations to automatically receive, record and display photos taken by weather satellites. The move, a spokesman said, is being made to enhance customer liaison—the customer being Goddard Spaceflight Center. Other FSC missile/space work will continue to be performed on Long Island. . . . *Torrance, Calif., operations of Ryan Aeronautical Co. will be moved to San Diego, Calif., and all production and engineering facilities will be consolidated there by May 1. Now having access to added plant space in San Diego, Ryan is making the shift to achieve closer liaison and greater efficiency between its electronics design and manufacturing operations. The company plans to sell its 40-acre Torrance property, with administration, engineering, production and support facilities totaling 360,000 sq. ft. of working space.* . . . Leach Corporation, maker of electronic components and subsystems for missile/space applications, will open a new corporate headquarters at San Marino, Calif., April 1. The 18,000-sq.-ft. facility built by O. K. Earl Corp., will be located approximately midway between Leach's Controls Div. (Azusa) and its Avalon facility (Los Angeles). Present headquarters are in Compton, Calif. . . . *Universal Match Corp. has set up a new field engineering office at Huntsville, Ala., to represent its Unidynamics Div. as well as Reflectone Electronics, Inc., a subsidiary.* . . . A recent $100,000 expansion program has doubled the production facilities of Lindberg Steel Treating Co.'s Rochester Div. An increase in the plant's working force is expected to be necessary to realize the full capability of the expanded operation. . . . *New offices set up in Houston, Los Angeles, and Washington, D. C., by Whirlpool Corp.'s Systems Div. will handle sale of hardware as well as R&D and other services to the government and to government-funded prime contractors. Systems Div. was set up last September to handle all such sales.* . . . Radio Corp. of America has set up its fifth regional office for its Defense Electronic Products Div. Located in Colorado Springs, Colo., the office will serve the West Central U. S. . . . *Ultek Corp., manufacturer of electronic high-vacuum pumps and systems for space simulation, says it is building one of the country's largest industrial manufacturing clean rooms on the San Francisco peninsula. Ultek plans to pressurize the entire 15,000-sq.-ft. production area. Moving day from the present Palo Alto, Calif., site to the new plant at Mountain View, Calif., will be at the end of February, establishing Ultek as the first tenant of the new Casey Industrial Park.* . . . In a move to expand capabilities for manufacture of large rocket booster motor components, Lear Siegler Inc.'s Astro Structures Div. is building a new 20,000-sq.-ft. building adjacent to its El Segundo, Calif., plant. The new building will give added support to the firm's Spin Forge facility, which is used to fabricate motor cases and other major rocket and missile sections. . . . *A new $750,000 metals technology laboratory at Portland, Ore., will develop advanced metal alloys for Martin Metals Co., a subsidiary of Martin Marietta Corp. The laboratory, with a staff of 25-30 scientists and technicians, is an outgrowth of a research project sponsored by Martin Metals at Stanford Research Institute. It will specialize in high-temperature materials and processes for missile/space applications.* . . . Singer Manufacturing Co.'s Singer Metrics Div. has moved operations of its recently acquired Sensitive Research Instrument Corp. from New Rochelle, N. Y., to Singer's Bridgeport, Conn., plant. SRI's operations at its new home began Jan. 21. . . . *Systems Engineering Laboratories, two-year-old Fort Lauderdale, Fla., firm is planning its third major expansion since it began operations. It is reportedly scouting the Fort Lauderdale area for a site it can either lease or buy. The firm expects annual sales to exceed $4 million by next year.* . . . American Gage and Machine Co.'s Size Control Co. Div. has opened a new plant in South Pasadena, Calif., to serve the market in the West. American's home base is Chicago.

Taber TELE-NEWS
about TELEDYNE® and TELEFLIGHT® instrumentation



new Taber strain gage DC amplifier boosts low level signals to 5 volts

Extremely refined, Taber's Series 290 Amplifiers have wide application in airborne and ground support systems, low level communications systems, and analog computers. With entirely welded construction, epoxy encapsulation and stainless steel outer cases, the amplifiers provide optimum performance under extremes of vibration and temperature using no choppers and all solid state components.

Gains are factory set from X100 to X500. Linearity is better than 0.05%. Available with thermal gain stability to better than 0.0025% per Fahrenheit degree from −65°F to +250°F and thermal zero stability better than 1.5 microvolts per Fahrenheit degree (referred to input). Output impedance is approximately 8 ohms.

When used in conjunction with a Taber Strain Gage Pressure Transducer, this new amplifier provides a 5 volt DC full scale output in precise relation to the strain gage input. Weighing 1½ oz., the 290 measures ⅞" x ⅞" x 1½". It can be combined with any Taber Transducer to provide a Transducer/Amplifier unit in a single package.

Detailed, illustrated literature on Taber Strain Gage DC Amplifiers may be obtained by mailing this coupon attached to your letterhead.

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AEROSPACE ELECTRONICS DIVISION SECTION 217
107 Goundry Street, North Tonawanda, N. Y.

Send detailed information on Taber Strain Gage DC Amplifiers.



name _____ title _____

company _____ dept. _____

address _____

city _____ zone _____ state _____

contracts

AWARDS

AIR FORCE

$20,909,000—**Boeing Co.,** Seattle, for *Minuteman* weapons system work at Vandenberg Air Force Base, and for fixed assembly and checkout of equipment at *Minuteman* sites at Ellsworth Air Force Base (2 supplemental contracts).

$6,000,000—**Hercules Powder Co.,** Wilmington, Del., for research and development for Stage III *Minuteman* motors (supplemental contract). Work to be done at Bacchus, Utah.

$6,000,000—**International Telephone and Telegraph Corp.,** New York City, for fabrication and delivery of electronic equipment (supplemental contract). Work to be done at Paramus, N.J.

$6,000,000—**General Dynamics Corp.,** New York City, for modification of *Atlas* operational and training sites and for procurement of ground support equipment for space programs (2 supplemental contracts).

$4,500,000—**Avco Corp.,** Wilmington, Mass. for further work on the *Minuteman* re-entry vehicle (supplemental contract).

$3,800,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for production of space vehicles.

$3,155,000—**Systems Development Corp.,** Santa Monica, Calif., for development and preparation of system training program (supplemental contract).

$3,010,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on space programs and space systems (2 supplemental contracts).

$2,168,872—**Western Electric Co.,** New York City, for work on BMEWS communication system (supplemental contract).

$2,000,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for research and development work for *Minuteman* missile bases (supplemental contract).

$1,725,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for engineering and engineering services for improvement of *Genie* rocket motors.

$1,615,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for provision of launch service capability for the Pacific Missile Range.

$1,513,600—**Space Technology Laboratories,** Redondo Beach, Calif., for work on space programs.

$1,400,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for communication equipment to be used in the Strategic Air Command's Airborne Command Post program.

$1,353,244—**Goodyear Aircraft Corp.,** Akron, Ohio, for equipment and service to increase TM-76A *Mace* missile launch facilities in West Germany.

$1,133,806—**Melabs, Inc.,** Palo Alto, Calif., for work on mobile electronic reconnaissance equipment.

$1,289,578—**Aerojet-General Corp.,** Azusa, Calif., for research and development work for the *Titan II* propulsion systems. Work to be done at Sacramento, Calif.

$1,200,000—**American Machine and Foundry Co.,** New York City, for repair of a Beale Air Force Base *Titan* missile silo in the vicinity of Chico, Calif., (supplemental contract).

$1,100,000—**Rand Corp.,** Santa Monica, Calif., for research in aerospace sciences (supplemental contract).

$298,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for laying technological groundwork for deploying plastic foam that becomes rigid on expandable objects in space.

American Bosch Arma Corp., Arma Div., Garden City, N.Y. for development work on advanced nuclear gyro.

Circle No. 22 on Subscriber Service Card

Portable Vapor Cycle Air Conditioning for Electronic Cooling



3-TON UNIT TYPICAL PERFORMANCE SPECIFICATIONS

36,000 Btu's cooling,
75 cfm ventilating air
(optional 18,400 Btu's heater);
26x26x36 in., 235 lbs.;
400 cycle, 3 phase power.



Smaller size, lighter weight, proved operational reliability

Compactness and Lightweight: Garrett-AiResearch 400 cycle vapor cycle air conditioning packages are based upon experience of designing, manufacturing, and supporting nearly 100,000 airborne and ground air conditioning systems.

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- More than 2.5 million operating hours accumulated on commercial refrigerant compressors.
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- Ambient operating range from −65° to 125°F.

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- Lightweight and small size meets all field deployment requirements.
- Module capacities from 1.5 to 10 tons of refrigeration can be transported by hand.

Write for literature to Environmental Control Systems, AiResearch Manufacturing Division, Los Angeles.

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Circle No. 14 on Subscriber Service Card

ARMY

$16,590,039—**General Dynamics Corp.'s Pomona Div.**, Pomona, Calif., for continued research and development on the *Mauler* missile system. Work to be done at Pomona; Boston; San Jose, Calif.; and Paoli, Pa.

$7,691,623—**Paul Hardeman, Inc.** Staunton, Calif., in joint venture with Morrison-Knudsen, Inc., for construction of spacecraft, operations and checkout building at Merritt Island, Fla.

$1,250,000—**General Electric Co.,** Schenectady, N.Y. for research with radar for the ballistic missile defense system.

$1,008,486—**Hicks Corp.,** Asheville, N.C., for *Honest John* rocket components.

NAVY

$5,000,000—**General Telephone and Electronics Corp.,** Mountain View, Calif., for design and production of special-purpose direction finding equipment.

$4,554,563—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, for production of accelerometers for the *Polaris* missile program. Work to be done at St. Petersburg, Fla.

$3,820,203—**General Motors Corp.'s AC Spark Plug Div.,** Flint, Mich., for production of accelerometers for *Polaris* missile program. Work to be done at Milwaukee.

$2,650,000—**General Electric Co.,** Pittsfield, Mass., for modular test sets for *Polaris* missiles.

$1,250,000—**University of Chicago,** Chicago, Ill., for fundamental research in nuclear physics.

$292,400—**Republic Aviation Corp.,** Farmingdale, N.Y., for acceleration of its space-engine development work.

NASA

$3,600,000—**Bell Aero-Space Corp.'s Bell Aerosystems Co.,** Buffalo, N.Y. for design and construction of two manned lunar landing research vehicles.

$4,030,000—**Air Force Systems Command,** additional funding for FY-1963.

$1,900,000—**Radiation, Inc.,** Melbourne, Fla., for production of one prototype and eight additional digital command encoders for the worldwide manned spaceflight tracking network.

$69,453—**Lear-Siegler, Inc.,** Anaheim, Calif., for two sets of slow scan TV equipment for possible use on the *MA-9* flight if proved compatible with capsule.

$54,306—**Armour Research Foundation of Illinois Institute of Technology,** Chicago, for study and possible models of multidirectional impact attenuation system prototype for *Apollo* command module passengers.

$32,600—**General American Transportation Corp.,** Niles, Ill., for environmenttal control system evaluator.

INDUSTRY

$8,000,000—**Kaiser Aircraft & Electronics Div. of Kaiser Industries Corp.,** Oakland, Calif., from **Thiokol Chemical Corp.,** for production of thrust vector control nozzles for Stage I solid propellant motors of the *Minuteman* ICBM.

$668,000—**Custom Tool and Manufacturing Co.,** Minneapolis, from **Aeroject-General's Solid Rocket Plant,** for *Polaris* motor nozzles and jetavators.

$475,000—**Textron, Inc.,'s Dalmo Victor Co. Div.,** Belmont, Calif., from **Republic Aviation Corp.,** for airborne antenna systems.

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- STANDARD ORDNANCE DEVICES

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TO ANTICIPATE TOMORROW'S NEEDS...for reliable, compact, lightweight systems and components, McCormick-Selph will help you realize the full potential of controlled explosive energy to meet your most advanced design requirements.

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TO RELEASE/TO STABILIZE/
TO INFLATE/TO ACTUATE/
TO IGNITE/TO PULL/TO PUSH

Circle No. 23 on Subscriber Service Card

$346,000—**Atlantic Research Corp.**, Alexandria, Va., from **Space-General Corp.**, for fluid tankage for the Stage II *Minuteman* motor thrust-vector-control system.

$302,500—**Reeves Instrument Corp.**, Garden City, N.Y., from **Sperry Rand Corp.**, for navigational support equipment for the Dept. of Defense.

$296,318—**Olin-Mathieson Corp.**, Minneapolis, from **Space-General Corp.**, for gas generators for Stage II *Minuteman* motor-thrust-vector-control system.

$282,680—**Moog Servocontrols, Inc.**, for the Stage II *Minuteman* motor thrust-vector-control system.

$123,000—**Standard Manufacturing Co., Inc.**, Dallas, Tex., from **The Boeing Co.**, for design, development and manufacture of trailers for moving the *X-20 Dyna-Soar* spacecraft on the ground.

$25,000—**Victoreen Instrument Co.'s Jordan Electronics Div.**, Alhambra, Calif., from **Martin-Denver Co.**, for design and production of a five-channel programmer for the *Titan II* missile.

Weston Instruments Div. of Daystrom, Inc., Newark, N.J., from the **Boeing Co.**, for a Weston-designed instrument that will record the sequence and timing of operational *Minuteman* launches (undisclosed amount).

book reviews

DESIGN OF HYDRAULIC CONTROL SYSTEMS, Ernest E. Lewis, McGraw-Hill Book Co. New York. 349 pp., $12.50.

The book provides the necessary background to devise analog simulation techniques for hydraulic circuit design and to apply control systems theory to commonly used hydraulic actuation and power transmission systems.

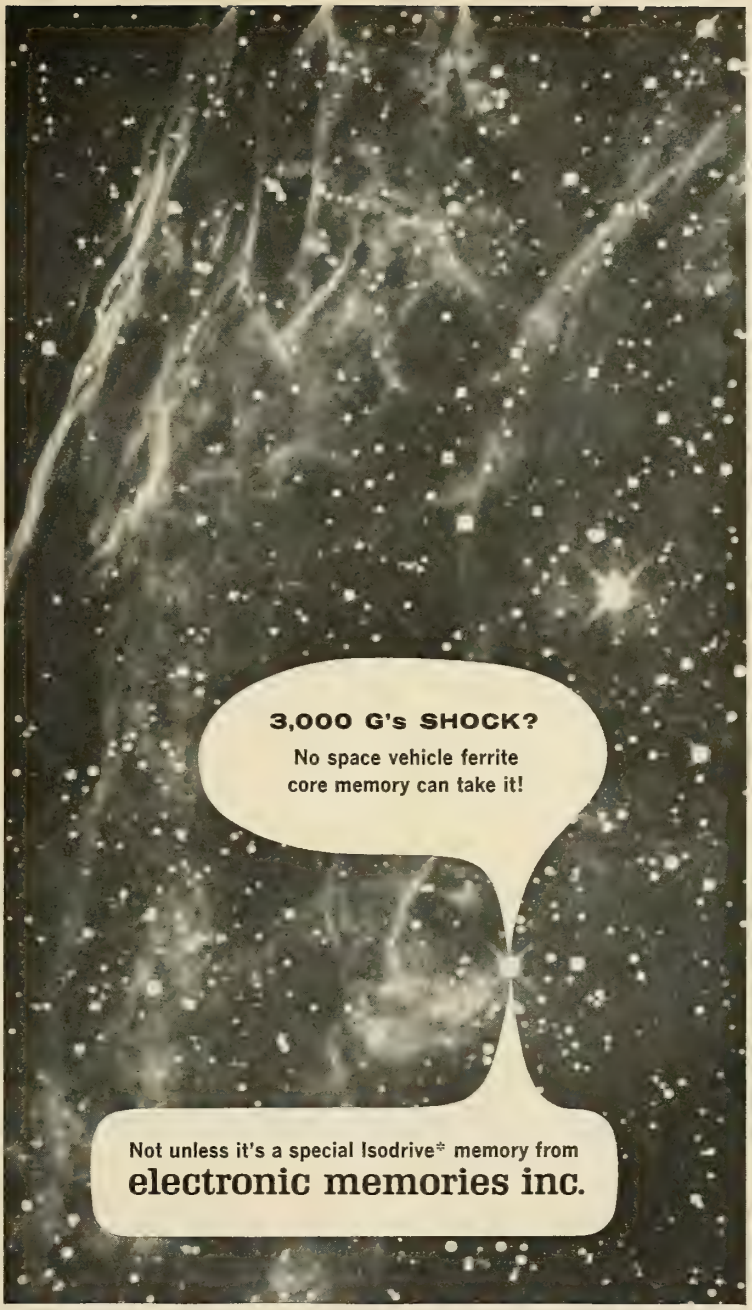
Practical design applications are stressed to provide a survey of the fluid control design techniques.

Among topics covered are: characteristics of hydraulic control components, fluid characteristics, control-system materials, components and elements for circuit design, feedback control, components transfer functions, measuring control dynamic characteristics, computer simulation techniques, hydraulic control circuits, and design practice.

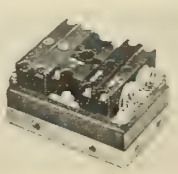
PRINCIPLES OF ELECTRONIC WARFARE, by members of technical staff of Convair, Prentice-Hall, Inc., Englewood Cliffs, N.J., 213 pp., $8.00.

The practice of electronic warfare is described from a technical viewpoint. However, the book is easily read, the equations are relatively simple and should not be at all burdensome for the average engineer, and the information given is practical and current.

Happily, there is no discussion of specific equipment: the authors tried for a fundamental approach to the problem, and appear to have succeeded. Contents: scope of the problem; technique and tactics; noise, probability, and information recovery, electronic reconnaissance, radar considerations, role of antennas in electronic warfare, optimization—constraints and incomplete information, and some aspects of electronic warfare in the space era.

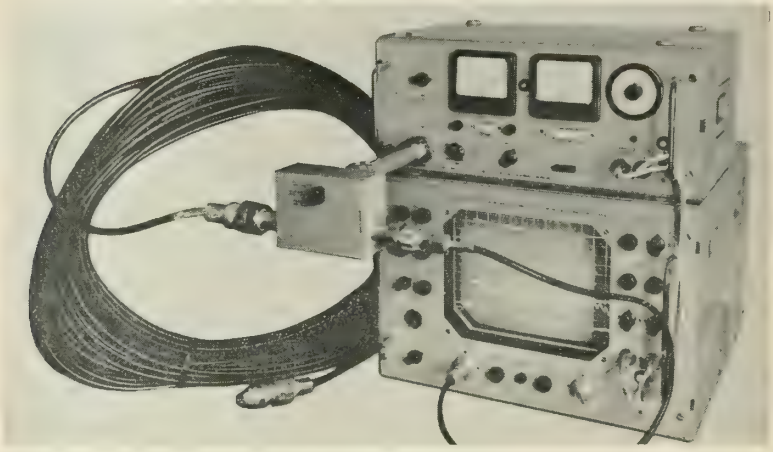


Take a 1440-bit memory. Accelerate it at 180 mph into a balsa structure. As it hits, decelerating 3,000 G's in 3 milliseconds, feed it information. Then see what it remembers. ■ That's what Ford's Aeronutronic Division did to one of our SE1440Z1A Isodrive* memories. Results? Perfect! The memory was still intact. So was the data. Likewise our claim that a 1.2-pound, 2" x 3" x 5" core memory with a 50,000-bit/second read/write cycle could do it. And that's not to mention a calculated mean-time-to-failure of 60,000 hours while exposed to ambient temperatures from —20°C. to +60°C. ■ At Electronic Memories, Inc., conquering shock is only part of the story. Across the board, our capabilities in MIL-Spec ferrite cores and memories are extensive. It's all spelled out in our capabilities brochure. Shouldn't you have one? Write Dept. C, 9430 Bellanca Ave., Los Angeles 45, Calif.



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New Product of the Week:

Measuring System

A test system, the Reflectomat, for instantaneous wideband electronic measurement of cables, terminations, connectors, and antennas is available from Rohde & Schwartz Sales Co., Inc. In the 30-to-400-mc range, the test system has a dynamic range of 60 db and a reflection coefficient range of 0.1% to 100%.

The Reflectomat test system comprises three basic elements: the Polyskop swept-frequency system, the selectomat tracking preamplifier, and reflectrometer. The system has a large 14-in.-screen display with no parallax error. Precision connectors establish a well defined reference point and reduce measuring errors because of their low VSWR.

Circle No. 225 on Subscriber Service Card

Silicon Transistor

The 30-amp NPN silicon power transistors that feature low-saturation resistance and high gain are available from the Westinghouse Semiconductor Div.

The series 2N1830 and 2N2130 can be supplied in voltage ratings from 50 to 200. Typical saturation resistance of the device is 0.035 ohms, and a minimum gain of 10 at 25 amps collector current. The unit also features an unusually high steady-state power dissipation of 250 watts, and a peak power capability of 6000 watts. Junction operating and storage temperature limits are from −65°C to 175°C.

Circle No. 226 on Subscriber Service Card

CURTISS-WRIGHT ELECTRONICS...

adding a new dimension to the capability of man



C-BAND RADAR is equipped with plan position, range-height and azimuth range scope indicators. Sweep ranges for the plan position indicator are 30, 60, 120 and 200 nautical miles. Sweep ranges for the range-height indicator are 15, 30, 60 and 120 nautical miles with height scales of 0 to 40,000 ft. in 5,000 ft intervals and 0 to 80,000 ft. in 10,000 ft. intervals. The receiver-transmitter-modulator unit can be housed with the antenna assembly or remote up to 100 feet.

Depth Transducers

Servonic Instruments, Inc., has developed two series of transducers applicable to underwater research.

Accurate to 1%, these potentiometer-type transducers operate at depths from 20 to 40,000 ft. They are sealed in stainless steel cases and immune to corrosive action of salt water.

The Series 307 absolute pressure transducer is recommended for shallow probing. Accurate indication of its aneroid capsule starts two feet below the surface (1 psi). The high-level a-c or d-c output is linear with depth and can be used without amplification. When referenced to its suspended depth, the unit can also provide a differential pressure output to measure wave motion, peaks, and troughs.

Circle No. 227 on Subscriber Service Card

Torsional Delay Line

A piezoelectric direct-drive torsional delay line that operates without a mode converter has been developed by General Electric for applications subject to extreme shock and vibration.

In addition to reducing sensitivity to vibration and shock, use of the transducer removes frequency restrictions inherent with a mode converter and increases efficiency. Primarily intended for uses in missileborne and airborne digital memories, the device can be designed for delay up to five milliseconds, and frequencies up to three mc. for the shorter delay-time designs.

Circle No. 228 on Subscriber Service Card

Thin Film-Making Process

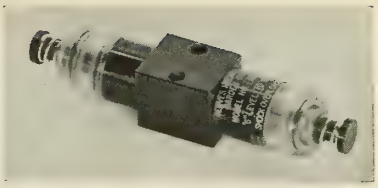
A "maskless" process for producing thin film circuits has been developed by General Dynamics/Astronautics.

The process eliminates the need to make masks and to change tooling within the vacuum chamber when a change of circuitry is required; initial tooling is simple. One operator and one vacuum station can produce up to 2000 passive circuits per day.

Circle No. 229 on Subscriber Service Card

Shock Indicator

A high-precision, magnetically controlled shock overload indicator is being marketed by Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America. The indicator is sensitive to forces in either direction along one plane and is factory calibrated to respond to any predetermined shock level in the range of two to 100 g's. Accuracy



is within ±5% of nominal. The unit meets all environmental specs in accordance with MIL-E-5272.

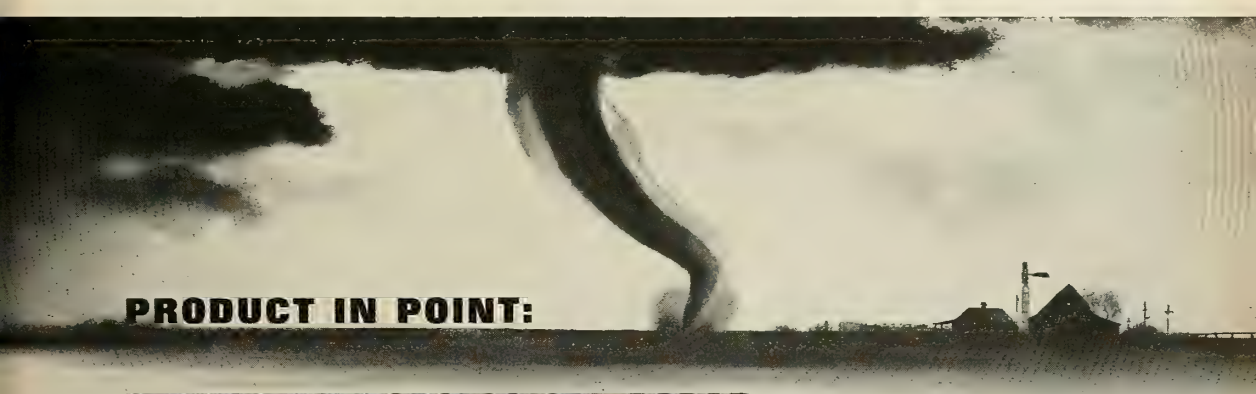
The indicator is designed to provide visual indication when a shock condition exceeding a calibrated level is reached. This is accomplished by means of red tabs which lock into position and are visible through clear lucite caps located at either end of the cylindrical device. A plunger mounted to the lucite cap permits manual reset.

Circle No. 230 on Subscriber Service Card

Beryllium Oxide Ceramics

Beryllium oxide ceramics, 98% and higher in purity, in shapes and sizes comparable to many of those attainable in alumina ceramics, are available from American Lava Corp.

In the range of 100°C, thermal conductivity of the beryllia may be about 10 times that of an AlSiMag alumina ceramic. This beryllia has a dielectric



C-BAND METEOROLOGICAL RADAR

. . . sets new standards for weather analysis!

At Curtiss-Wright, new applications of science and technology develop products which become integral parts of military and industrial programs.

Product in Point: C-Band Meteorological Radar—this precision, land-based system obtains more accurate weather data than can now be acquired by any standard radar unit. It provides greatly increased cloud penetration yielding new and vital information for the detection and analysis of storms, tornadoes and other weather phenomena.

This equipment is but one example of the challenging radar projects being carried out by Curtiss-Wright engineers. Others include the RMT-100 radar maintenance trainer now in wide service throughout the world; Model 57-9 six-target radar simulator currently training air traffic control personnel; plus the more elaborate Model 58-2 two-target, three-dimensional radar target simulator.

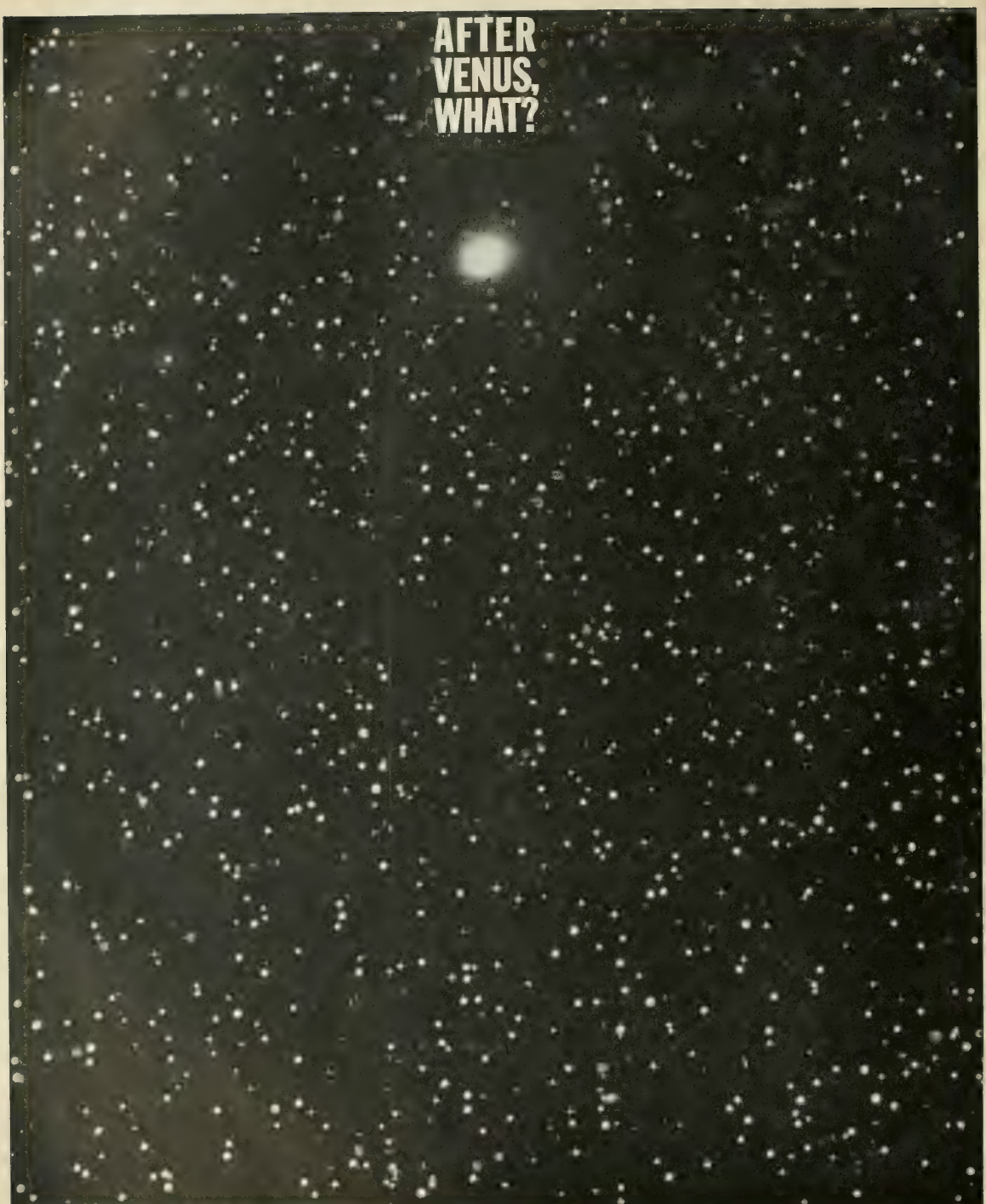
These and other advanced activities have created immediate opportunities for systems engineers and circuit designers with RF and video experience.

For complete information, write Mr. H. Gene Kelly, Manager of Professional Placement, Electronics Division. An equal opportunity employer.

ELECTRONICS DIVISION

CURTISS-WRIGHT CORPORATION

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Sure we at JPL are elated with the success of our Mariner 2. But Venus is just one important way station on the long journey through space. There are lots more things to be done:

Soft moon-landings. Landings on Mars. Jupiter fly-bys. Electronic probes of other planets. And more Venus trips.

Yes, there's much left to do out there. Much of it will continue to be done by the scientists and engineers at Caltech's Jet Propulsion Laboratory. They think for a living. If you do, think of yourself as part of JPL's exciting world of other-world exploration. A resume to JPL could make you a part of it.

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Attention: Personnel Department

"An equal opportunity employer." Jet Propulsion Laboratory is operated by the California Institute of Technology for the National Aeronautics and Space Administration.

constant only about three quarters that of the alumina. The Te value is about twice that of alumina. Beryllia ceramics have a low nuclear capture cross-section, and good moderating properties in addition to their superior high-temperature characteristics. Thus it is indicated as a structural material for fuel elements, reflectors or moderators for high-temperature nuclear reactors.

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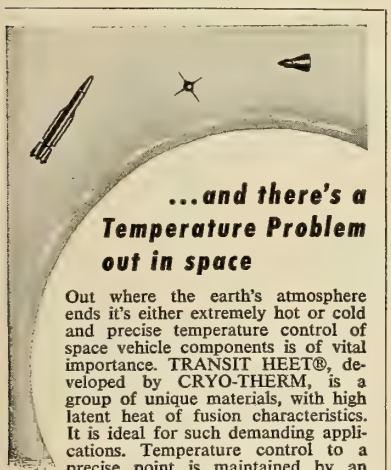
Pressure Controller

A calibration pressure controller which provides precise control of pressure to a primary pressure standard has been introduced by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.

Designated the Type 6-003, the unit contains controls for coarse pressure adjustment, feed and vent valves, and vernier pressure adjustment by a pressure-volume regulator. Input, feed, and vent pressure fittings are provided, as well as a pressure gage, filter and an interconnecting hose.

Input pressure range is 0 to 2700 psi from an external bottle or generator source; pressure from 0 to 15 psig can be generated internally with the pressure volume-regulator. Operating temperature range is from 60°F to 100°F.

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...and there's a Temperature Problem out in space

Out where the earth's atmosphere ends it's either extremely hot or cold and precise temperature control of space vehicle components is of vital importance. TRANSIT HEET®, developed by CRYO-THERM, is a group of unique materials, with high latent heat of fusion characteristics. It is ideal for such demanding applications. Temperature control to a precise point is maintained by an unique heat transfer system operating on a basic thermodynamic principle which eliminates batteries or other power supplies during operation.

The TRANSIT HEET System has solved a variety of temperature stabilization problems in many fields. An example is the shipping containers for Polaris inertial guidance systems. It may also answer your temperature control problem on the ground or in space. Write:

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Precision-Controlled Thermodynamic Systems

OPPORTUNITIES FOR SCIENTISTS AND ENGINEERS

Circle No. 25 on Subscriber Service Card

Ionization Chamber

An advanced ionization chamber designed for automatic, remote measurement of ionizing radiation flux is available from Electro-Optical Systems, Inc. Designated Model No. IC-5, 1962, the instrument is sensitive to radiation from any direction over a wide dynamic operating range. Its output signal, consisting of pulses at a frequency proportional to incident flux, can vary from one pulse per seven hrs. to 100/second —equivalent to a flux range from 0.01 MR to 50 R/hr. The chamber wall permits passage of alpha particles of 40 mev or more, beta particles equal to or greater than 0.5 mev, protons of 10 mev and above, and all gamma rays.

The instrument tolerates temperatures from −50°C to 150°C, vibration up to 5 g sine wave along any axis, shock up to 200 g of 3 to 4 milliseconds duration, and accelerations up to 5 g in any direction.

Circle No. 233 on Subscriber Service Card

Performance Analyzer

A line of transistorized, portable radar-performance analyzers providing overall performance measurement and continuous monitoring has been developed by Sperry Microwave Electronics Co. All essential measurement capabilities are provided for field maintenance support, operational monitoring and factory evaluation of surveillance radars; matched filter, pulse compression, coherent or non-coherent MTI, Doppler, pulse-Doppler or conventional types.,

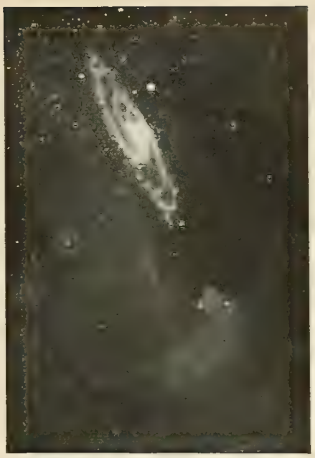
These analyzers provide true rf minimum-discernible-signal monitoring on pulse compression and matched filter systems, cancellation ratio measurements in MTI systems and increased measurement accuracy and monitoring convenience in conventional systems.

Circle No. 234 on Subscriber Service Card

Calibrator

Available from Telemetrics, Inc., the Model 6206 DAC calibrator powers, displays and calibrates up to 50 digital-to-analog converters. The unit features display of any of 50 channels in real time, and permits any bit combination between zero and full scale. A decimal calibrate control provides linear calibration levels as a percent of full scale for rapid DAC and oscillograph checkout. The levels are in 10% steps from 0 to 100%. The unit accepts as input eight data lines and 50 DAC lines. A switch is incorporated to change the analog polarity output.

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Unusually interesting positions exist for qualified engineers who can perform on a variety of high interest aerospace vehicle studies and who have a capability for proposal preparation.

Responsibilities for the area will include: Preparation of preliminary concepts, structural and component installation designs for proposals and advanced studies in missiles and spacecraft programs; performance of weight, balance and inertia studies; providing written proposal materials.

Experience in aircraft or missile structural design is essential, with a working knowledge of preliminary stress analysis, effects of extreme environment, and applicable materials. Applicants should be generally familiar with various vehicle subsystems, particularly in the propulsion and attitude control areas.

Qualifications should include a B.S. degree from an accredited university with 5 to 10 years applicable experience.

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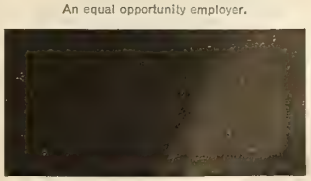
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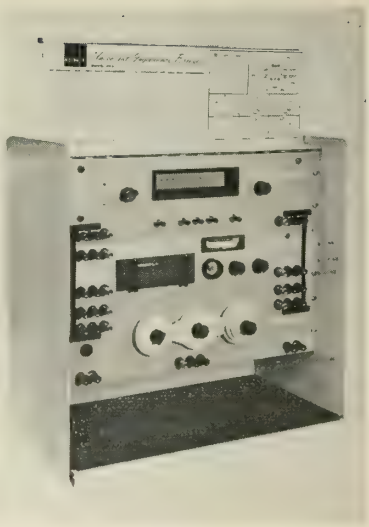


Magnetometer

A direct-readout magnetometer using the principle of proton-free precession to measure the Earth's magnetic fields from 20,000 to 100,000 gammas has been developed by Varian Associates' Instrument Div.

Designated the V-4931DR, the system uses the proton principle in conjunction with phase-lock circuitry to present a direct gamma readout of magnetic fields visually on a digital counter and graphically on an analog strip-chart recorder. The resulting information requires no further correlation or conversion, and is an absolute measure of the Earth's magnetic fields accurate to ±1 gamma.

Circle No. 236 on Subscriber Service Card



Impedance Measuring Unit

Available from Electro Scientific Industries, Inc., the ESI 291 B Universal Impedance Measuring System is a matched assembly of the Model 290 A impedance bridge, the Model 840 d-c generator-detector and the Model 860 a-c generator-detector. The system measures resistance, conductance, inductance, capacitance and the dissipation factor and storage factor of capacitors and inductors. Accuracy is rated at ±0.05% for resistance and conductance; ±0.1% for inductance and capacitance. Comparative measurements can be made to five significant figures using the 120,005 divisions provided by the ESO Dekadial Decake Dials.

Circle No. 237 on Subscriber Service Card

Microminiature Connectors

A series of high-reliability microminiature circular connectors for cable-to-cable or cable-to-chassis applications has been developed by Amphenol Connector Div., Amphenol-Borg electronics Corp.

Environmental versions are available that meet or exceed performance requirements of Mil-C-26482. This specification calls for connectors to be subjected to 375 volts rms at altitudes up to 70,000 ft. and to 1500 volts at sea level. The connectors also must withstand five continuous temperature cycles between −55 to 125°C.

Circle No. 238 on Subscriber Service Card

Angular Motion Transducers

Servonic Instruments, Inc., is marketing a series of 500 angular motion potentiometer type transducers for use in high accuracy servo systems. These units provide remote indication of rocket gimbal angles, control surface positions, etc. Designed to accommodate angular misalignment, it absorbs linear, axial and eccentric movement while maintaining a rotational sensitivity of 0.1° and accuracy of 0.5%.

The Model 5017 weighs 8 oz. max-

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This insulated, air-conditioned trailer was built by Dorsey for General Electric Company's Missile and Space Vehicle Department to house checkout equipment for the Nimbus space craft.



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imum and has a life expectancy in excess of 250,000 cycles ±32° from null. It will withstand random vibrations up to 103 GRMS without electrical discontinuity and operate in temperate extremes from −35° to 275°F. Other specifications include: electrical angle, 64°; mechanical angle, 73° maximum; resolution, 0.10° maximum; linearity, ±5% of applied voltage; resistances, 500 ohms to 25,000 ohms ±5%.

Circle No. 239 on Subscriber Service Card

Admittance Bridge

Beenton Electronics Corp. is marketing the RF admittance bridge, Model 33A with self-contained oscillator and detector. The unit incorporates a novel bridge network that provides adequate range, resolution and accuracy under the required d-c bias conditions. All variable elements in the bridge are air capacitators, thus insuring continuous smooth operation without calibration deterioration for the life of the instrument. There are no false or sliding nulls.

The test frequencies of the device are: 1, 5, 10, 20, 30, 40, and 50 mv. The capacitance range is 0 to 150 pf, while the conductance range is 0 to 6000 μmhos. The d-c bias range is −5 to 100v.

Circle No. 240 on Subscriber Service Card

Reliability Slide Rule

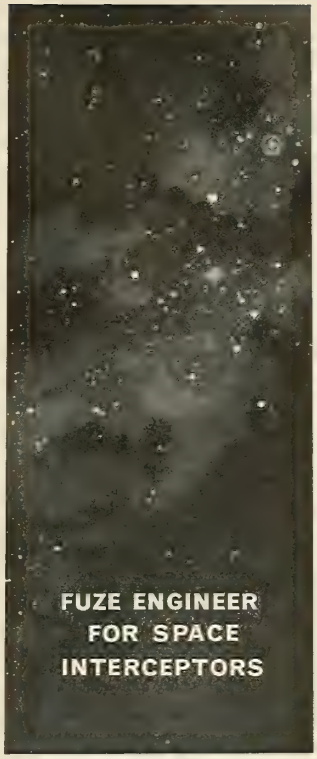
An advanced reliability and confidence slide rule has been developed by Aero Geo Astro Corp. for use in the analysis of reliability problems. The slide rule is circular and 4 in. in diameter, with two independent faces for the calculation of different reliability parameters. Side A calculates mean to time to failure, given reliability and hours of operation; reliability, given mean time to failure and time, and hours of operation, given mean time to failure and reliability. Side B calculates mean time between failure lower bound (or the upper bound of failure rate) for selected confidence levels, given total hours of operation and observed number of failures, and total hours of test for various confidence levels, given lower bound for mean time between failure and observed number of failures.

Circle No. 241 on Subscriber Service Card

Silicone Rubber

A silicone rubber compound specially formulated to meet military specification MIL-R-5847D (Class III-25) and Aerospace Material Specification AMS-3332 has been developed by Union Carbide Corp., Silicones Div.

Designated K-1203, it is an extreme low temperature, 25 Durometer stock.



An expert in unconventional applications and techniques is offered an exceptional opportunity to conduct fuzing studies for space interceptors in Hughes Advanced Projects Laboratory.

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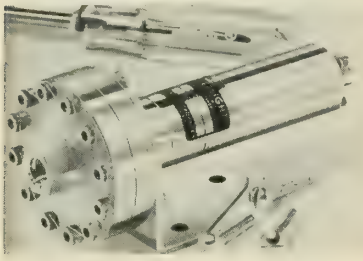
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Easily processed, it has the added feature of use as a base compound from which stocks can be fabricated with a wide range of hardnesses in the extreme temperature range. It can be cured using any of the standard catalysts employed for silicone rubber compounds, and is available catalyzed or uncatalyzed.

Circle No. 242 on Subscriber Service Card

Transducer/Amplifier

The Teleflight(R) Model 179/290-1 transducer/amplifier, available from Taber Instrument Corp., is designed for space vehicle and rocket applications.



Combining a bonded strain-gage transducer and a solid-state amplifier in a pressure-sensing system, the instrument has a 5-v d-c output.

Special design of the Taber package reduces vibration and acceleration sensitivity. The unit also has fast response to transient pressure and can withstand pressure overloads up to three times full scale without damaging the instrument or necessitating recalibration.

Circle No. 243 on Subscriber Service Card

Control Panel

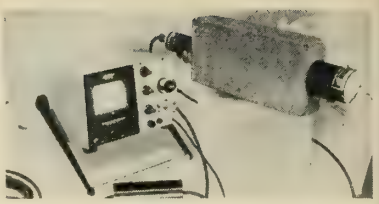
A joystick control panel for high-speed, two-axis servo postitioning has been developed by Nuclear Research Instruments Div., Houston Fearless Corp. The unit can be applied to any system requiring two-dimensional control, such as motor phasing, planar measurements, positioning for ballistic and optical tracking, cathode ray display beam-positioning, and other information and data display devices.

Opening for joystick motion is a 1½-in.-diameter circle. Standard resistance value is 10,000 ohms, ±5% with 0.1% linearity; others available on special order. Using 10,000 ohms as the standard (5000 ohms on each side of center tap), the maximum power is 3.5 watts at 40°C. The assembly can tolerate a range of −55° to 85°C. Operating range is 15°C to 35°C.

Circle No. 244 on Subscriber Service Card

Material Tester

A portable ultrasonic instrument for testing concrete, wood, plastic, rubber



and other materials has been developed by Branson Instruments, Inc.

Designated the Sonoray Model 20, the battery-operated unit is suitable for both flaw detection and determination of strength characteristics of solid rocket propellant.

The unit uses the pulsed-through-transmission technique by sending a pulse of high-frequency sound between two transducers and measuring the elapsed time. This permits calculation of the velocity of sound in the part, which in turn is directly related to the modulus of elasticity and other strength characteristics of the material.

Circle No. 245 on Subscriber Service Card

new literature

REINFORCED PLASTICS — A brochure on engineered plastics for space, electronics, aviation and industrial applications has been published by the Taunton Div., Haveg Industries, Inc. The 16-page publication describes the division's research and development laboratories and facilities for compression, transfer, injection and specialty molding; manufacture of intricately shaped elastomers and foam products; applications for Havelex, a glass bonded mica; and production of sealing caps and tubes.

Circle No. 200 on Subscriber Service Card

WATERPROOF PLUGS — Cannon Electric Co. offers a catalog that describes its W series of waterproof plugs, which are designed to provide a watertight solution for any connector moisture problem—whether deep under water or in a surface application.

Circle No. 201 on Subscriber Service Card

MINIATURE TUBULAR CAPACITORS—A series of miniature tubular capacitors with weldable leads for cordwood packaging, is described in an illustrated bulletin available from Gulton Industries, Inc. Sized identical to a 0.25 watt resistors, the series of ceramic capacitors are 0.095 in. diameter by 0.255 in. long. Their dumet leads are plated with gold for maximum weldability. Capacitance values range from 10 to 1000 MMF in tolerances of 5%, 10% and 20%. The capacitors are rated at 50 d-c over a temperature range from −55°C to 150°C.

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SERVO NEWS

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—names in the news—

Dr. Kenneth S. Colmen: Named general manager of American Machine and Foundry Co.'s Alexandria, Va., division.

Roy E. Drew: Elected Controller of Sylvania Electric Products, Inc., New York City.

Lloyd K. Jensen: Appointed manager of Northrop Corp.'s Space Laboratories Eastern U.S. Regional Office, Washington, D.C. **Jonas R. Moore** appointed manager of the Western U.S. Regional Office, Los Angeles.

Harold Treece: Named division manager of the Electro-Ceramics Div. of Automation Industries, Inc., Boulder, Colo.

Alvin Clavin: Appointed director of marketing for Rantec Corp., Calabasas, Calif.

Dr. Arthur B. Greenberg: Appointed director of Propulsive Vehicle Systems, Aerospace Corp., Los Angeles. **Leo J. Julakowski** appointed head of the Performance Analysis Dept.

David E. Trumbull: Appointed manager of General Electric Co.'s TEMPO operation, Santa Barbara, Calif.

Walter Williams: Named division manager of Dyna-Therm Chemical Corp.'s Thermal Space Div., Los Angeles.

Col. Bernt Balchen (USAF ret.): Joined General Precision, Inc., Tarrytown, N.Y., as special assistant to the vice president of government marketing.

Lt. Col. Robert Chesney (USAF ret.): Joined Corning Glass Works as government marketing services representative for the Radome Dept., Corning, N. Y.

H. M. Conner: Named assistant to the president of Fairchild Stratos Corp., and manager of the Washington, D. C., office.

Henry A. Thouron: Elected president of Hercules Powder Co., Wilmington, Del.

Donn K. Jenkins: Appointed vice president and general manager of the Howard Research Corp., Arlington, Va.

Algie A. Hendrix: Appointed vice president-industrial relations of General Dynamics Corp., New York City.

Dr. R. W. Detra: Named vice president, missile programs, of Avco Corp.'s Research and Advanced Development Div., Wilmington, Mass. **A. J. Maki** appointed vice president, manufacturing.

W. Howard Ingle: Joined the staff of the Sensor Data Div. of Aero Service Corp., Philadelphia, as a technical representative at Wright Patterson AFB and other installations in the Southeast.

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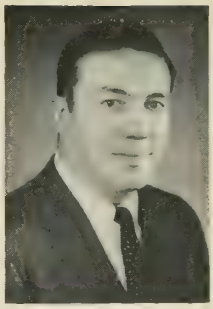
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Karl G. Harr, Jr.: Named president of the Aerospace Industries Assn. of America, Inc., Washington, D.C. **Irving H. Taylor,** former head of the Export Service, named consultant to the organization on export matters.

John P. Wright: Appointed president of Astropower, Inc., subsidiary of the Douglas Aircraft Co., Newport Beach, Calif.

Kenneth L. Rech: Named technical manager, space suit engineering, B. F. Goodrich Aerospace and Defense Products, Akron, Ohio.

Dr. Ralph L. McCreary: Appointed director of research and development for Motorola Inc.'s Military Electronics Div., Scottsdale, Ariz.

Dr. C. James Barr: Appointed director of production, Lockheed Propulsion Co., Redlands, Calif.

W. V. Warner: Appointed director-government marketing of Universal Match Corp., St. Louis.

Ewell Edward Mason: Appointed senior consultant to the McDonnell Automation Center, St. Louis.

Joseph V. Miccio: Appointed to the newly created position of president of the Wright Aeronautical Div., Curtiss-Wright Corp., Wood-Ridge, N. J.

Andrew J. Unetic: Elected to the board of directors of Kinetics Corp., Solana Beach, Calif.

Stephen Jack: Appointed director of customer requirements of Thompson Ramo Wooldridge's Space Technology Laboratories, Redondo Beach, Calif.

George V. Woodrow, Jr.: Named director, research and engineering for LFE Electronics division of Laboratory for Electronics, Inc., Boston.

Roger T. Verhage: Appointed manager of sales and service activities for the data-processing divisions, Consolidated Electrodynamics Corp., Los Angeles.

Vinton D. Carver: Appointed director of operations for the Data Systems Div. of Litton Industries, Canoga Park, Calif.

Dan T. Kennedy: Appointed general manager of the newly formed Velonex Div. of Pulse Engineering, Inc., Santa Clara, Calif.

Dr. Marvin Adelberg: Joined the staff of Arthur D. Little, Inc., Santa Monica, Calif., as engineering manager.

Lawrence Zeitsoff: Appointed general manager of the newly established Technical Services Div. of Consultants & Designers, Inc., New York City.

Dr. Aladdin N. Perkins: Appointed director of research for the Tucson Research Laboratory of Textron's Bell Aerosystems Co., Tucson, Ariz.

Dr. Robert Adler: Appointed vice president-director of research, Zenith Radio Corp., Chicago. **Dr. Alexander Ellett** named vice president-special scientific projects.

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—when and where—

JANUARY

National Plant Engineering and Maintenance Show and Conference, McCormick Place, Chicago, Jan. 28.

Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn., International Inn., Washington, D.C., Jan. 28.

12th Annual Quality Control Clinic, Minnesota Section, ASQC, Leamington Hotel, Minneapolis, Jan. 29.

Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

1963 Winter Convention on Military Electronics, IRE PG MIL, Ambassador Hotel and IAS Bldg., Los Angeles, Jan. 30-Feb. 1.

Institute of Radio Engineers Winter Convention on Military Electronics, Ambassador Hotel, Los Angeles, Jan. 30-Feb. 1.

FEBRUARY

American Society for Testing and Materials Committee Week, Queen Elizabeth Hotel, Montreal, Can., Feb. 4-8.

Engineering for Major Scientific Research Programs Symposium, Georgia Institute of Technology, Atlanta, Feb. 5-6.

Electronic Sales-Market Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationales des Industries Electroniques, UNESCO Bldg., Paris Feb. 11-15.

Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory, Engineers Club, Dayton, Ohio, Feb. 12-13.

American Society for Quality Control Annual Reliability Symposium, Statler-Hilton Hotel, Los Angeles, Feb. 20.

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Colo., Feb. 18-19.

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A Military Space Setback

THE *GEMINI* AGREEMENT between Secretary of Defense McNamara and NASA Administrator Webb has been widely touted by the Administration as a move toward a manned military space program.

Despite these bland assurances, the prospects of a truly effective military space effort appear to be dimmed considerably by the agreement.

It's axiomatic in government circles that where the money is, the power is. And the money in *Gemini* is firmly in the hands of NASA. The AF financial contribution will be minor.

The Air Force has been thrown a crumb in the *Gemini* agreement. What, meanwhile, has it lost? Considerable. There are no funds in the new budget for *Blue Gemini,* a program which would provide AF with its own capsules. *Dyna-Soar (X-20),* the Air Force's own military space program, is seriously threatened by the NASA-DOD agreement.

Top Administration and Air Force sources confess that the entire *X-20* project is being re-evaluated in the light of the new agreement. Pentagon sources report that the *Dyna-Soar* budget already has been cut by five percent. There is a very good chance the program will be further reduced or cancelled altogether, with the argument that many of its objectives can be attained in the NASA-managed *Gemini* program.

Cancellation of *Dyna-Soar* also would result in a new look at *Titan III,* which the Air Force has designed as a standard launch vehicle for a number of space programs. A major cutback in *Titan III* does not yet seem to be in the cards, but dropping of the *X-20* project certainly would reduce available funds.

Dyna-Soar, at the moment, is the only approved payload for *Titan III.* Its disappearance would remove much of the urgency from the *Titan III* effort.

There have been a number of industry rumors in recent weeks—and at this stage they can only be classified as rumors—that *Titan III* is next on the list for the DOD axe. These are not confirmed by DOD. There are many programs in the research stage which would require the storable liquid-solid booster. Its development must continue if a launch vehicle is to be available for any of these projects which receives a go-ahead.

In another setback, under the new NASA-DOD range agreement, Air Force has lost management responsibility for a great part of Cape Canaveral. NASA will manage the new 87,000-acre lunar site while AF will retain control over only the existing 15,000-acre portion.

Maj. Gen. Ben Funk, commander of the Air Force Space Systems Division, charged full tilt at Administration space policy in his speech written for delivery at the Institute of Aerospace Sciences meeting last week in New York.

He declared flatly that the military has stringent requirements of reliability and performance that NASA cannot satisfy. It is quite evident that NASA's *Gemini* mission of rendezvousing with cooperative objects in space is far less demanding than the AF requirement to intercept passive and quite possibly hostile space satellites or weapons.

Funk put heavy emphasis on three programs which the Air Force considers imperative in its space plan. He called these "examples of prime military necessity." They are:

- Rendezvous and Inspection. *Blue Gemini, Saint* and *Dyna-Soar* fall in this category.
- Manned Orbital Development Station.
- Communications Satellite.

It is interesting to note that all three of these programs are tied closely to *Titan III* in Air Force planning. The *Titan III* also will have a quick-reaction capability needed by the military—which *Saturn* lacks.

It also is interesting to note that of the three military programs cited only one, communications satellites, appears to have met with any Dept. of Defense enthusiasm in the Fiscal '64 budgeting.

We do not wish to put Gen. Funk in the wrong light with his DOD superiors. He lauded the NASA-DOD agreement. We suspect this was because he had no option. His statements add up to a clear argument against present Administration space policy—even if the general didn't say so himself.

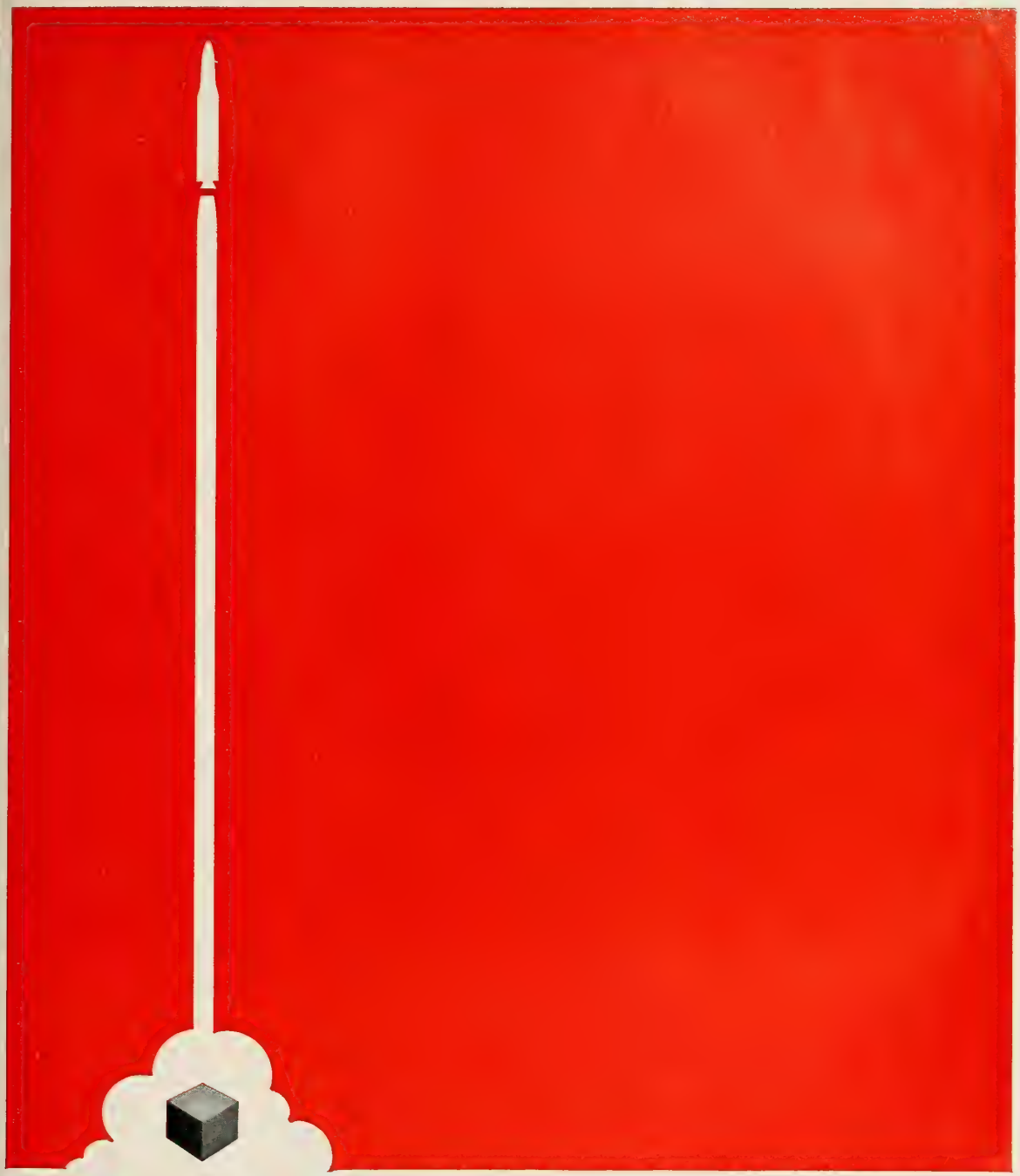
If these three programs are of "prime military necessity," then all three should be well-funded and active programs. They are not.

THE POLICY OUTLINED in the NASA-DOD agreement weakens to a great extent the chances of implementing the military space program so urgently needed. It provides Administration officials with a convenient argument that the Air Force has a manned military space program in *Gemini*—whereas, in fact, it does not.

There is only one bright spot in the picture. NASA Administrator Webb stated after the budget message: "I think we will have to fight for Congressional approval of the increased space budget. A great many people are concerned that the budget has been raised to $5.7 billion."

The new agreement has at least increased the chances of getting the NASA budget past Congress. But let's not kid ourselves that it provides the U.S. with an effective military space program.

William J. Coughlin



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FEBRUARY 4, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



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To initiate a search for celestial sources of "soft" X-rays, Lockheed (under NASA sponsorship) has developed and built photon counters to be carried aboard sounding rockets. Thus a survey of the night sky will be made for sources which emit photons in the 100-to-10,000 electron volt energy range.

Of interest to most engineers and scientists is the fact that this investigation was originated by a young Lockheed physicist. He realized that no serious attempt was being made to investigate those wave lengths just below the ultraviolet. Many similar developments have been evolved by Lockheed people who find here the creative freedom they need to pursue their own original ideas.

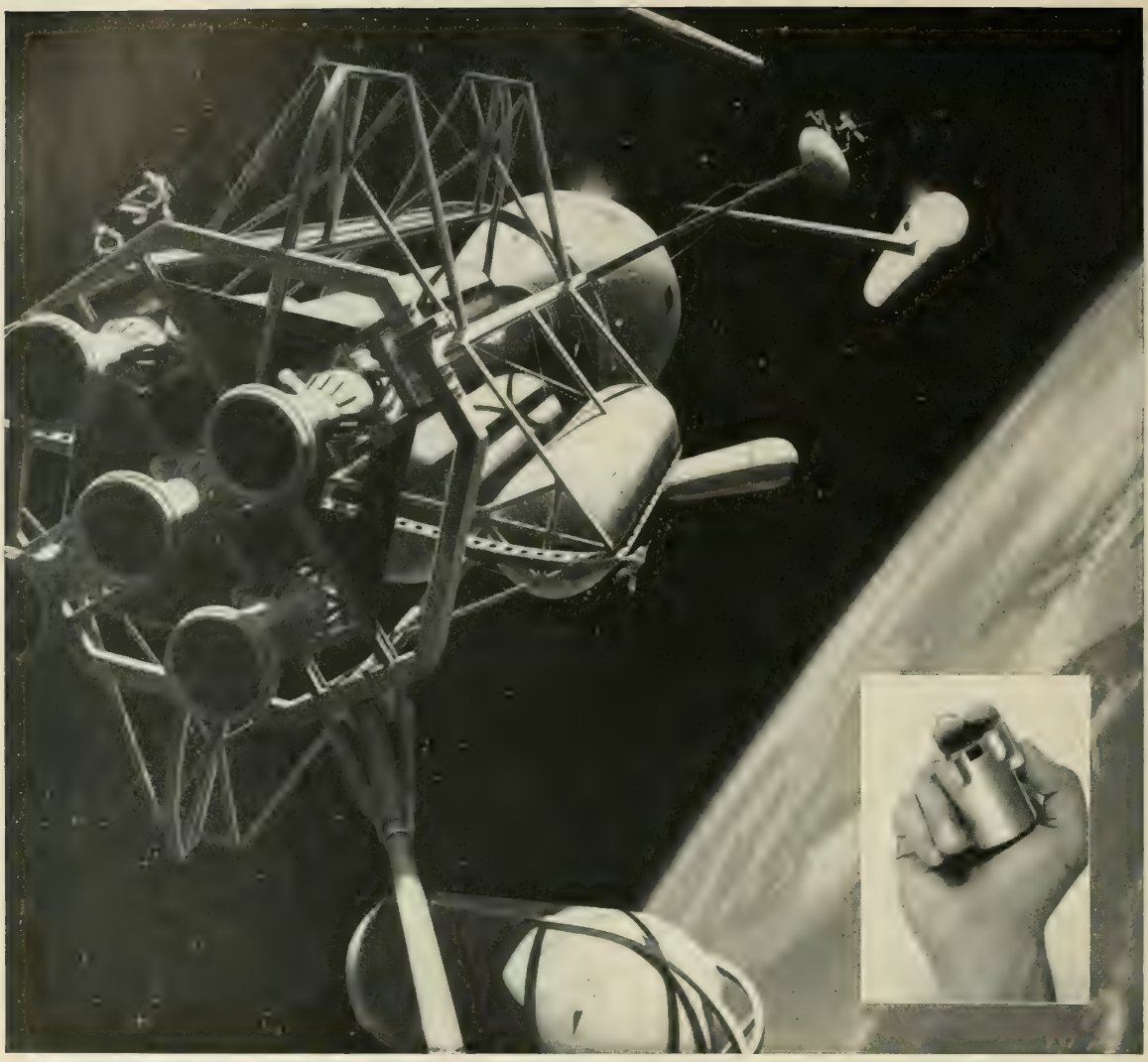
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 5 February 4, 1963

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THE COVER

Assembled Polaris launching tubes shown ready for shipment to the Navy at Westinghouse Sunnyvale Div., where they were built. Launch control mechanisms are in the ends of tubes near camera.



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†U.S. Reg. Pdg.

Downgraded Gain Values

In your Nov. 12, 1962, issue (p. 43), you published an item on the Transistor Amplifiers produced by our client, Kane Engineering Laboratories. We are appreciative.

However, it seems our secretary's typewriter has a half-hearted "O" and the release when duplicated had a number of "O" 's that came out "C" 's. This is why the last line of our release stated voltage gain values of "2C and 4C db" when they should have been "20 and 40 db."

The results of all this seem to be somewhat like a pay check amount printed "300 degrees centigrade."

George C. Coakley
G. Coakley & Co.
San Jose, Calif.

Russian Capacities

To the Editor:

I read with great pleasure your Jan. 14 editorial ("The Soviet Threat") and I believe that those persons in the DOD who expressed their thoughts in the earlier article titled "DOD Says AICBM Is Feasible" (M/R, Dec. 24, 1962, p. 14) should re-read your above-mentioned editorial five times.

How can we, for one single second, believe that the Soviet Union will NOT set out to achieve a particular objective? History has proved that they can accomplish any objective that they choose—be it subs, missiles or conventional weapons. In this critical time, how can we assume that we can be successful just because our "gross national product" figure is greater than that of the Soviet Union? Of what aid will our great capacity to print comic books be when bombs are exploding all around us?

Herbert E. Wodtke
Senior Technical Publications Writer
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Universal Time

To the Editor:

Here is a suggestion to aid in the coordination of all the data from all projects in the field of biomedical research (space application known as bioastronautics).

It is essential that a common base be established in the approach to data programming and data processing—this fourth dimension is known as universal time.

This will allow our researchers all over the world to correlate specific results and also negative results with many geophysical parameters heretofore overlooked in many projects.

By having a "WWV" radio time pulse incorporated with all laboratory recordings, it is possible to later return and superimpose many environmental factors onto our research. To list a few:

—Weather, temp., pressure, humidity, winds, Sun, clouds, etc.

—Position of Sun, Moon, tides, Earth flattening harmonics.

—Magnetosphere variations, Van Allen belt variations, particle dumping flux, enhancement flux, density and charge.

First, provide a radio receiver with fixed reception on "WWV" time pulse. Second, provide a 1 in./sec. audio tape recorder which will record the radio time pulse and the researcher's verbal comments.

Sydney Combs
Lexington, Ky.

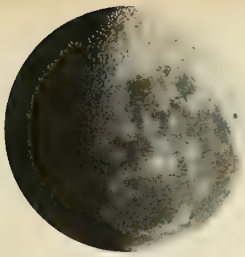
Cislunar Chart Reprints

Reprints of the chart, Properties of Cislunar Space," which appeared in the Jan. 21 M/R are now available from:

Research Department
Missiles and Rockets
1001 Vermont Ave., NW
Washington 5, D. C.

The reprint price is 50 cents per copy. Payment must accompany order.

The chart, mailed in a tube, will be suitable for framing.



Boeing has been awarded primary developmental, building and test responsibility for NASA's Saturn S-IC advanced first stage booster. Aero-Space Division's new Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

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The Countdown

WASHINGTON

Plans for LLV Development Cancelled

NASA is cancelling plans for a finalized design of its *Lunar Logistics Vehicle*. There are no development funds for *LLV* in either the FY '63 or FY '64 budgets. Further study contracts will be awarded, however.

No McNamara Encouragement for Dyna-Soar

Air Force officials in the *Dyna-Soar (X-20)* program flinched at last week's Congressional budget report from Defense Secretary McNamara. He emphasized what he called the "very difficult technical problems" still unsolved in the program and avoided stating publicly how much money will be applied to the *X-20* project. AF belief: the axe is coming.

NASA Budget Hearings To Begin This Month

It now appears that Congressional hearings on NASA's Fiscal 1964 budget request of $5.7 billion will begin in mid-February. House Space Committee will lead off. Senate hearing schedule still is indefinite. Although Sen. Clinton Anderson (D.-N.M.) has declared he is willing to accept the committee chairmanship, no organization meetings have been held.

Aerospace Plane Funding Is Stepped Up

Funding of subsystem development for *Aerospace Plane* as a recoverable booster is being stepped up in the Fiscal '63 and '64 budgeting. That's the word from top Air Force officials.

NASA Studies Three-Day Mercury Mission

There's very little chance that the *Mercury* capsule will be adapted for a three-day mission. NASA admits, however, that such a plan to increase its capability has been under study. Current plans are to halt the *Mercury* program if the *MA-9* flight in April is successful. Only an unsuccessful flight or a long delay in the start of *Gemini* could change this.

Regulus Is on the Way Out

Phase-out of five *Regulus*-equipped submarines is scheduled to start this year. The subs have been operational for several years. They carry a total of 17 missiles.

NASA Sets Funding for BIOS Program

Funding for the *BIOS* satellite program has been set by NASA at $11.7 million for the spacecraft and $12.7 million for the launch vehicle. First launch in the life support program is to be in 1964 from the Pacific Missile Range. Booster will be *Atlas-Agena*.

Need for AMR-PMR Link Is Ruled Out

One of the items disapproved by Defense Secretary McNamara in his $13-billion slash of the Pentagon budget was a $16.7-million communications link between the Atlantic and Pacific missile ranges. The link was viewed as desirable but marginal.

SAINT Shift Due to Gemini Advances

Air Force Systems Commander Gen. Bernard Schriever says the reorientation of the *SAINT* program was imposed by the Air Force because its technology was being overtaken by the *Gemini* project. He describes the new *Satellite Inspector* project as "active" in regard to sensors.

Is the U.S. Navy Expendable?

Secretary McNamara, discussing Navy air-defense missiles, has questioned the wisdom of expending funds "simply to defend the fleet against air attack." He says a thorough analysis is required to determine the military value of the fleet against the cost of defending it.

High-Energy Propulsion Studied for Apollo

NASA plans to develop a high-energy propulsion system for the *Apollo* spacecraft service module to serve as backup to the lower-energy non-cryogenic propellants now specified. The high-energy system will be required only if there is a significant increase in weight of the spacecraft.

Soviet Attack over Antarctic Seen Possible

Dept. of Defense concedes that the Soviet Union could launch a successful ICBM attack over the South Pole to avoid the BMEWS warning system. Since this would be at the cost of both accuracy and payload, attack across the Arctic still is considered the more likely.

DOD Censors AF Space Film

Dept. of Defense reviewers have deleted a scene from a new Air Force space film which showed a battle of laser weapons between a Soviet orbital vehicle and U.S. spacecraft. The sequence also showed the Soviet craft knocking out ascending *Titan* missiles with lasers.

INDUSTRY

Fallout from Skybolt Program Is Foreseen

Air Force recommendations for disposal of data and technology developed in the cancelled *Skybolt* program have been forwarded to Secretary McNamara's office. From these, the Secretary will make his decision on items of R&D that may hold promise for future systems development. Historically, some should prove useful. A good portion of North American Aviation's cancelled *Navajo* program found application. Another unused system Autonetics developed for the B-58 spilled over in philosophy, if not hardware, to *Hound Dog* and *Minuteman* guidance.

AF Computer Simulation Set for X-20

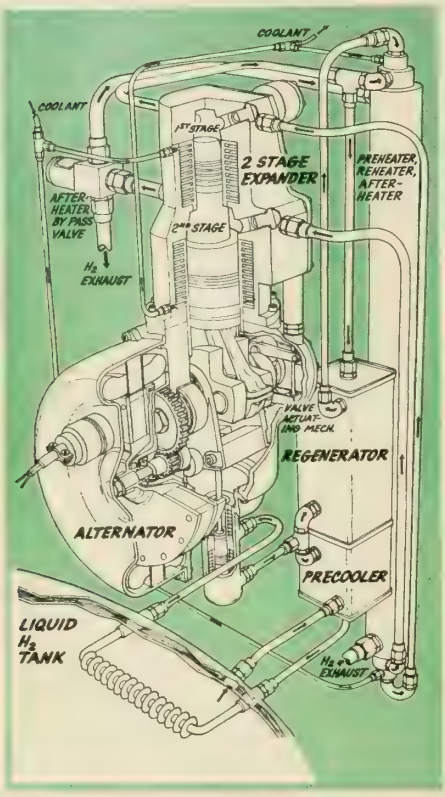
Air Force will begin computer simulation of *Dyna-Soar* missions next month at Edwards AFB. Unlike the hardware-oriented *X-20* simulation program at Boeing Co., the AF program is intended to measure the constraints of the design on operations and flight planning.

INTERNATIONAL

Sweden Sets Substantial Buy of Seacats

Two orders placed by Sweden for the British *Seacat* antiaircraft missile are described by Short Brothers and Harland as "substantial." The orders were placed after trials of the missile by the Swedish Navy (M/R, Dec. 17, p. 38).

A RELIABLE SPACE POWER AND THERMAL CONTROL SYSTEM FOR LUNAR EXPLORATION



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The Missile/Space

Lockheed Labor Bout Ends

Employees of Lockheed Aircraft Corp. have accepted a company proposal in a landslide vote—settling a long-fought dispute between Lockheed and the International Assn. of Machinists.

The agreement—favored in a secret ballot by 85% of 4000 voting IAM members—did not include the union shop provisions for which IAM officials had fought an intense campaign.

However, the company agreed to require any employee who joins the union to remain a member as a condition of employment, and all new employees will be strongly urged by the firm to join the IAM.

Settlement at Lockheed was not expected to have any immediate effect upon the IAM's present bout with the Boeing Co. A recent District Court injunction temporarily enjoins the union from striking at Boeing.

Firms Picked in LEM Talks

Grumman Aircraft Engineering Corp. and NASA's Manned Spacecraft Center at Houston have chosen the following firms for pre-negotiation talks on various systems for the Lunar Excursion Module:

—North American Aviation's Rocketdyne Div., for development of a throttleable engine using a gas-injection scheme for LEM control on descent to the lunar surface.

A parallel program will be conducted by another contractor—not yet chosen—for development of a variable-area throttling engine. Early in these programs, one of the two technical approaches will be selected for development completion.

—Bell Aerospace Corp.'s Bell Aerosystems Co., for development of the engine to be used in ascent from the Moon and rendezvous with the *Apollo* command and service modules.

—Marquardt Corp., for development of components for the reaction-control system that will orient and stabilize LEM.

—United Aircraft Corp.'s Hamilton Standard Div., for development of LEM life-support systems. Eventual value of this project is estimated at $5-9 million, with NASA reportedly favoring the lower figure.

Hamilton Standard previously received a contract for design and development of suits for astronauts to

wear outside the lunar landing craft while exploring the Moon.

NASA said the contract being negotiated with Grumman will have an estimated value of $387.9 million.

Shots of the Week

A Strategic Air Command crew launched a Martin *Titan I* ICBM from Vandenberg Air Force Base, Calif., Jan. 29 in a training exercise.

Minutes after the launch, an Air Force spokesman said the shot was apparently successful, with preliminary telemetry data indicating the 98-ft. missile hit its target area 5000 mi. out in the Pacific.

• Another Vandenberg launch, that of an *Atlas* ICBM Jan. 25, was also successful. The Air Force announcement said only that the firing of the General Dynamics/Astronautics missile was a routine training launch for SAC missile crews.

• An Army *Pershing* surface-to-surface missile met all test objectives on a 200-mi. flight Jan. 30 from Cape Canaveral. The missile was fired from its transporter-erector-launcher by a Martin/Army team on the eve of the fifth anniversary of launching by the Army of the U.S.'s first successful satellite—*Explorer I.*

The *Pershing* was tilted at launch to simulate hurricane winds, corrected itself, and made what was described as a "very successful flight."

MA-9 Launch Date Set

Astronaut L. Gordon Cooper is scheduled to make the longest space ride ever undertaken by NASA next April 2.

Tentative plans call for Cooper to make 22 orbits—a flight that would take 34 hrs. and bring him down in the vicinity of Midway Island in the Pacific, near the site of Walter Schirra's landing last October.

Kennedy Hails Space Pact

President Kennedy believes that the new working relationship between NASA and the Dept. of Defense at managerial and operational levels promises to be one of the most significant factors affecting the future of the U.S. space effort.

This he told Congress in his annual report on space achievements of the past year.

Communication satellite programs were cited in the report as exemplary of the cooperation in space research between the military and the civilian space agency.

Development of *X-20,* according to the report, has reached "a point where fabrication of the first gliders is expected to begin in 1963." This statement contrasted with recently reported fears in some quarters that the NASA-DOD pact might forbode a cutback or even cancellation of the *X-20* program.

U.K. To Share Polaris Costs

A plan for sharing development costs of the *Polaris A-3* may be muddying what seemed to be a clear understanding between the U.S. and Britain after last December's Nassau conference.

The Department of Defense has said that Britain will have to share *Polaris* development costs just as the U.S. is paying for part of the British-developed Hawker P1127 fighter plane that may find use in NATO.

Press Secretary Pierre Salinger refused to comment on reports that an Anglo-American misunderstanding had developed over the *Polaris-for-Skybolt* Nassau agreement.

London reports said Britain had understood that the U.S. would pay all development costs for the *Polaris* missiles it would sell to Britain at the price of production. These same reports said the British have now been told they are expected to assist financially in developing the 2500-mi.-range *Polaris A-3.*

AF Asks ComSat Proposals

The Air Force Space Systems Div. has asked for proposals from 34 firms for a medium-altitude communications satellite system.

The firms receiving the requests are: Aerojet-General Corp.; Airborne Instruments Laboratories; American Machine & Foundry; Bell Aerosystems Co.; Bendix Corp.; Boeing Co.; Chrysler Corp.; Collins Radio Co.; Douglas Aircraft Co.; Ford Motor Co.; General Dynamics Corp.; General Electric Co.; Grumman Aircraft Engineering Corp.; Hughes Aircraft Co.; International Business Machines Corp.; Goodyear Aircraft Corp.

Also, Ling-Temco-Vought, Inc.; Litton Systems; Lockheed Missiles & Space Co.; McDonnell Aircraft Corp.; Motorola, Inc.; North American Aviation, Inc.; Northrop Corp.; Radio Corp. of America; Raytheon Co.; Republic Aviation Corp.; Space Technology Laboratories, Inc.; Sperry Rand Corp.; Sylvania Electric Products, Inc.; United States Rubber Co.; Vitro Laboratories; Western Electric Co.; Martin Co.; and Western Electric Corp.

Rohr Gets Antenna Award

NASA has selected the Rohr Corp. of Chula Vista, Calif., to develop, install and test a 210-ft.-diameter antenna to be located at Goldstone, Calif. Estimated value of the contract is $12 million.

Completion of the antenna system, expected in three years, will improve the communications capability of the Deep Space Network (DSN) by a factor of ten. This improvement can be used to increase communication distances or to acquire larger amounts of data from shorter distances.

NASA Patent Proposal Hit

Rep. Chet Holifield (D-Calif.) has charged that "NASA is attempting to nullify the 1958 Space Act through back-door methods."

The Congressman hurled the charge during a public hearing Jan. 21 on proposed changes in the agency's patent waiver regulations. He told the hearing that whereas the Space Act provides that NASA may waive its patent ownership rights only in exceptional cases, the change would make waivers the general rule.

The proposed rule provides that NASA may waive its right to ownership of a patent to the firm which developed it. If the patent is worked after three years, NASA would retain the right to grant other firms non-exclusive licenses on it.

Sen. Ernest Gruening (D-Alaska) and Rep. William F. Ryan (D-N.Y.) also appeared at the hearing to oppose the projected rule change.

The hearing was ordered by NASA following Congressional charges last December that the agency was trying to push the rule change through while Congress was not in session.

The two main opponents of the action—Sens. Estes Kefauver (D-Tenn.) and Russell B. Long (D-La.) did not appear. However, they were expected to take up the attack with long speeches on the Senate floor.

McNamara testifies . . .

DOD Space Position Defended

Secretary stresses increasing AF role with NASA; highlights of budget report

by Frank G. McGuire

DEFENSE SECRETARY Robert McNamara, presenting to Congress a Fiscal 1964 military budget calling for expenditures of well over $10 billion on missiles and space, last week sharply defended his military space program.

Apparently in anticipation of Congressional criticism, McNamara stressed in a 163-page unclassified budget report what he called the increased interweaving of space activity between Dept. of Defense and the National Aeronautics and Space Administration. The classified report runs closer to 200 pages.

His testimony before the House Armed Services Committee pointed out that DOD did more than $550 million worth of work for NASA during 1962 and that nearly 200 Air Force officers now are assigned to NASA.

McNamara emphasized that the $1.650-billion military space program for FY '64 is $50 million more than FY '63 and nearly $400 million more than FY '62.

He noted that the FY '64 military space request accounts for more than 20% of the year's R&D budget, and as a single package, is greater than the program to develop strategic weapons.

The Defense Secretary cited two specific criteria which the military space program must meet: taken together with the NASA program, it must constitute an integrated national effort; projects supported by DOD must promise to enhance U.S. military power and effectiveness.

McNamara's budget plan for FY '64 procurement of missiles stands at $4.108 billion for all services, while RDT&E is $2.226 billion.

Air Force procurement of missiles, spares and related equipment is planned at $2.405 billion; Navy plans to buy $1.107 billion in missiles and related equipment; Army plans call for $580.7 million in missile procurement, and Marine Corps expects to buy $14.7 million in missiles.

RDT&E for missiles and related equipment is planned at: Air Force, $1.060 billion; Navy, $590 million; and Army, $576.6 million.

• **Where we stand**—As of now, McNamara told Congress, we have 650 manned bombers on 15-minute ground alert, more than 200 operational *Atlas, Titan* and *Minuteman* missiles on launchers, 144 *Polaris* ballistic missiles in submarines on station; and this force is constantly expanding as additional *Polaris* and *Minuteman* missiles enter the inventory, he said.

Even after allowing losses from initial enemy attack and attrition while our weapons are en route to targets, McNamara said, we would still have the ability to completely destroy the Soviet Union—without any help from our tactical air command, carrier-based Navy aircraft, or the *Thor* and *Jupiter* IRBM's, all of which are nuclear-armed.

There is increasing evidence, he pointed out, that the USSR is hardening and dispersing its sites, building missile-launching submarines and acquiring more missiles on a continuing basis. This tends to complicate our own defense picture and detracts from our ability to completely destroy the Soviet strategic nuclear forces.

"What we are proposing," he said, "is a capability to strike back after absorbing the first blow. . . . Such a force should have sufficient flexibility to permit a choice of strategies, particularly an ability to: (1) Strike back decisively at the entire Soviet target system simultaneously or (2) Strike back first at the Soviet bomber bases, missile sites and other military installations associated with their long-range nuclear forces to reduce the power of any follow-on attack—and then, if necessary, strike back at the Soviet urban and industrial complex in a controlled and deliberate way."

• **Where we will stand**—The defense secretary said there would be no change in the *Atlas* program, which now consists of 126 missiles on launchers;

Missile Spending Proposals in the New Budget

(in millions of dollars)

Program by Activities	BUDGET PLAN (amounts for procurement actions programed)			OBLIGATIONS		
	1962 actual	1963 estimate	1964 estimate	1962 actual	1963 estimate	1964 estimate
AIR FORCE						
1. Ballistic missiles	1,459,556	1,809,100	1,720,400	1,530,214	1,794,200	1,466,200
2. Other missiles	159,500	194,800	191,200	165,895	244,400	190,700
3. Modification of inservice missiles	50,400	78,300	153,300	52,062	71,600	139,100
4. Spares support	276,000	208,900	125,000	260,274	275,900	145,100
5. Other support	191,200	166,700	215,100	162,683	125,800	229,700
Total	2,136,656	2,457,800	2,405,000	2,171,128	2,511,900	2,170,800
ARMY						
1. Missiles	521,000	512,100	558,400	527,210	514,300	549,100
2. Missile spare parts		17,800	22,300		15,500	21,000
Total	521 000	529 900	580,700	527,210	529,800	570,100
NAVY						
1. Ballistic missiles	328,500	411,600	618,000	322,000	418,100	618,000
2. Other missiles	435,000	363,400	298,700	322,198	387,600	332,094
3. Modification of Missiles	7,600	4,900	4,500	7,600	4,900	4,500
4. Missiles spare parts	42,900	51,900	69,500	42,900	51,900	69,500
5. Missile support equipment and facilities	51,206	83,907	116,600	44,600	91,000	110,906
Total	865,206	915,707	1,107,300	739,298	953,500	1,135,000
MARINES						
1. Guided missiles and equipment	18,353	21,200	14,700	18,653	10,000	19,000
Total	18,353	21,200	14,700	18,653	10,000	19,000



McNAMARA notes slight rise in space funds, growing missile prowess.

and the soft launchers and their missiles will soon enter a phaseout schedule. He added that an option to speed up or slow down the phaseout is being retained.

Titan ICBM forces are in a similar status. To 54 *Titan I* missiles now on launchers, there will soon be added 54 *Titan II* missiles, with the entire 108 weapons in place by the end of this calendar year.

Minuteman, boosted from 800 to a total force of 950, will have three squadrons of 50 missiles each in place by July, 800 in place by the end of FY '65, and the remaining 150 missiles shortly thereafter.

The *Polaris* program has changed little since the previous budget, with 41 submarines fully funded, the last six in the FY '64 budget for $695 million. The first five submarines are equipped with the 1200-mile-range *A-1* missile, the next 12 with the 1500-mile-range *A-2,* and the remaining ships with the 2500-mile-range *A-3.* The first five will have to be retro-fitted with new launch tubes to accommodate the *A-3,* but eventually all the submarines will be equipped with the *A-3* model.

Six tenders will be deployed to service this fleet ballistic missile force, and Pacific Ocean facilities will be set up at Bangor, Wash., Pearl Harbor, and Guam.

The program for *Quail* missiles to assist in B-52 penetration has been completed.

In advanced systems, McNamara referred to *Polaris A-3;* an "advanced ICBM," presumably the advanced *Minuteman;* MMRBM and the increased use of warhead decoys and penetration aids to insure that missiles get through.

The entire strategic retaliatory forces package laid out by the Pentagon will require $7.3 billion in total obligational authority, a drop from $8.5 billion in FY '63 and $9.1 billion in FY '62.

• **Missile defense forces** — Noting that our greatest danger in coming years will be from ICBM's and submarine-launched missiles, rather than aircraft, McNamara briefly covered the U.S. anti-air defense situation:

Nike-Ajax: Being phased out.

Nike-Hercules: Still a very useful system, will be continued intact for several years.

Bomarc: Suffers from same defects as manned interceptors, but will be retained, since the missiles are already paid for.

Nike-Zeus: Would not be effective against a sophisticated threat in the late 1960's, but improvements are being undertaken on its successor.

Nike-X: To be developed on an urgent basis, but deployment deferred.

Total obligational authority requested for the missile and air defense forces is $2 billion, compared with $1.9 billion for FY '63 and $2.1 billion for FY '62.

• **By services**—Army missile funds for the upcoming fiscal year total about $581 million, including continuation of *Hawk* and *Hercules* procurement for the balance of the year, initial procure-

McNamara Says Skybolt Would Have Been $2-Billion Waste

SKYBOLT priced itself out of what was already a marginal existence.

This explanation of the air-launched ballistic missile's cancellation accompanied Defense Secretary McNamara's testimony before Congress last week.

Delivering the most detailed statement on the matter since the controversial dropping of the program, McNamara said *Skybolt* "would combine the disadvantages of the bomber with those of the missile. It would have the bomber's disadvantages of being soft and concentrated and relatively vulnerable on the ground and have the bomber's slow time to target. But it would not have the bomber's advantageous payload and accuracy, nor would it have the advantages usually associated with a manned system. It would have the lower payload and the poorer accuracy of the missile—indeed, as designed, it would have had the lowest accuracy, reliability and yield of any of our strategic missiles—without the relative invulnerability and short time-to-target of a *Minuteman* or *Polaris.*"

McNamara said *Skybolt* could not be used against strategic targets because it would take hours to reach its target while *Minuteman* could make the trip in 30 minutes. *Skybolt* would not be good for counter-city attacks, he declared, because its B-52 carriers would have to be committed early in a war, or else would be vulnerable on the ground to enemy missile attacks. He added that *Skybolt's* low-yield warhead would not be suitable for attacking hardened targets, a task best handled by the B-52's high-yield bombs.

The only remaining job possibility for *Skybolt,* in McNamara's view, was as a defense-suppression weapon—that is, knocking out Soviet defense installations so that the B-52 bombers can penetrate to their targets. But he noted that this task can also be handled by *Minuteman* and *Hound Dog; Skybolt* offered a special advantage in this particular role only as long as it appeared to be a cheaper way of doing the job.

• **Accelerating pricetag**—Unfortunately, this apparent advantage disappeared, the Defense Secretary said. He observed that the Air Force early in 1960 estimated total cost of *Skybolt* at $893 million to develop and procure. Each succeeding estimate was significantly higher, and the final estimate was $2.263 billion—not including warheads.

Stating that even these final figures were very unrealistic, McNamara pointed out that the Air Force had 28 flights planned for the missile by the end of 1962, but actually conducted only six. Flight time allotted for the *Skybolt* test program was much less than that allowed for the *Hound Dog* missile—a much less complex development.

Considering these unrealistic estimates of both time and money consumption, McNamara declared—together with the fact that the missile was well behind schedule—it is very likely that *Skybolt* would eventually have become a $3-billion program.

The cost of each missile, hanging on an alert bomber on the runway, was estimated at $4 million—or about equal to the initial cost of a *Minuteman* missile, complete with its silo. Cancellation of *Skybolt,* McNamara continued, saved about $2 billion, even after providing money for extra *Minuteman* missiles to handle the proposed *Skybolt* missions.

ment of *Mauler*, completion of procurement of *Little John* and *Sergeant*, continuation of procurement of *Honest John* and *Pershing* and $45 million for *Entac* and *SS-11* antitank weapons. For the nuclear-tipped *Davy Crockett*, about $13 million is provided.

Army's general-purpose forces will get *Mauler* missiles in the near future, causing an increase in the air-defense battalions, while the number of *Hawk* and *Hercules* battalions remains unchanged. Surface-to-surface missile battalions have been reduced with the replacement of *Redstone* and *Corporal* missiles with solid-fueled *Sergeant* and *Pershing*.

Navy's general-purpose forces will get $830 million in missiles and other combat ordnance, with the number of antiaircraft missiles adjusted to conform to the number of aircraft expected to be engaged. Air-to-air missiles include purchases of *Sparrow III* and *Sidewinder IC*. *Bullpup* air-to-surface missiles will be bought in both the standard versions, in the more powerful *B* version, and in the training model.

Marine Corps procurement of missiles will be largely *Hawk* antiaircraft missiles.

Air Force general-purpose forces will include the eight *Mace A* and *B* squadrons now deployed in Europe and Okinawa, with the *B* version hardened.

• **RDT&E**—The 250 sub-activities listed under research, development, test and evaluation classifications have been broken down into five groups: research, exploratory developments, advanced developments, engineering developments and management and support. It's from the first three categories that DOD gets its "technical building blocks" allowing an applications engineering job to be started under the fourth category.

Research allocations for the services have been increased slightly, while ARPA's research funds have remained stable. Funds for exploratory developments, including propellant research by all three services, as well as by ARPA, totals $1.171 million.

About one-third of AF's $330-million exploratory development program is devoted to space and space-related subjects.

ARPA's Project *Defender* has been continued with a request for $128 million, as part of ARPA's overall request for $256 million. Project *Vela* and advanced propellant chemistry are also studied under this category.

In advanced developments, the replacement for *Advent* appears to be a medium-altitude, random-orbit, nonstabilized system presently within the state of the art. Decision on a synchronous satellite for communications has been deferred.

Army's *Shillelagh* weapon system is expected to be moving into the engineering development stage by FY '64 and is funded in that category. *TOW*, the infantry antitank weapon using optical tracking and wire guidance, is an effort to add first-round kill ability.

Other Army engineering developments include the *Nike-Zeus* family, funded at $89 million for *Nike-Zeus* and $246 million for *Nike-X*.

Lance, a lightweight battlefield missile designed to replace both *Honest John* and *Lacrosse*, is expected to move into large-scale development "provided that sufficient accuracy can be attained to make it an effective weapon."

Navy's engineering developments include *Typhon*, a surface-to-air weapon which does not appear to have full support of the Defense Secretary, but will be installed on a test ship as a prototype to undergo full-scale tests. *Sea Mauler*, an adaptation of the Army's weapon pod, is being adapted for shipboard use as a completely autonomous system—both surface-to-air and surface-to-surface.

During FY '64, the fully operational *Transit* system is expected to be introduced into fleet operations.

For the Air Force, the *MMRBM* program is still somewhat of a question mark, with FY '64 funds being requested for its continued development, but no decision yet from DOD on production or deployment.

The *Titan III* space booster is expected to require an additional $800-900 million to complete its development, but McNamara told the committee: "Because this project is justified primarily as a cost-saving program, its continued development will depend upon achievement of the cost objectives."

For the three national missile ranges: $74 million for White Sands, $173 million for Pacific Missile Range, and $249 million for the Atlantic Range. ⁂

Two Firms Planning Solid Nova Stage

A TOP NASA OFFICIAL has revealed that two industrial study contractors are designing a *Nova* booster with a first stage powered by four 23-ft.-dia. solid rocket motors.

Deputy Associate Administrator Robert F. Dixon also declared that the joint NASA-DOD solid propulsion program calls for eventual firing of several half-length 260-in. motors and two full-size vehicles.

Dixon's comments were made in an address before the American Rocket Society Solid Propellent Rocket Conference in Philadelphia last week.

He said that both Martin Marietta Corp. and the Boeing Co. have come up with *Nova* launch vehicle designs that could be powered by solid motors.

Martin, concerned with both liquid and solid stages, designed a vehicle which would have a payload capability of 800,000 lbs. in a 100-mi. orbit. The solid version would employ four solid motors about 23 ft. in diameter in the first stage; its second stage would be composed of five liquid hydrogen/oxygen engines.

Martin's all-liquid first stage would require clustering 17 F-1 engines with 1.5 million lbs. of thrust each, or 14 up-rated F-1 engines.

The Boeing study concentrated on a strictly solid *Nova* booster first stage. The vehicle designed would have a payload capability of 500,000 lbs. in near-Earth orbit. It also would be powered by four solid rocket motors about 23 ft. in diameter and would have only four liquid hydrogen/oxygen engines in the second stage.

The Boeing solid motors would develop considerably less thrust than those planned by Martin.

One other firm, General Dynamics/Astronautics, is also working on a *Nova* design study contract for NASA, but Dixon did not comment on its results.

• **Joint plan**—Turning to the more "definite and concrete" joint NASA-DOD solid propulsion development plan, Dixon said the major element of the program is the manufacture and testing of high-thrust engines 260 in. in diameter. The initial phase calls for building engines of approximately half the length of the final full-size engines. Only after the half-size engines have been proved in testing will the full-size engines be built.

"I want to make it clear that this project is not what might be called a development program. Only three or four of the half-length engines are to be built and tested, and only two full-sized engines," he said.

He added that each of the full-sized engines will cost some seven or eight million dollars, and on a per-lb. basis the half-engines probably will cost somewhat more.

Before the 260-in. engines are fired, the NASA official said, there will be a series of tests with 156-in. motors to evaluate nozzle structures, special materials for cases, and thrust-vector-control systems.

Syncom Will Be Another U.S. First

Satellite to test feasibility of synchronous concept

NASA in the near future will attempt to achieve the world's first synchronous orbiting satellite with the launch of its *Syncom* active communications spacecraft.

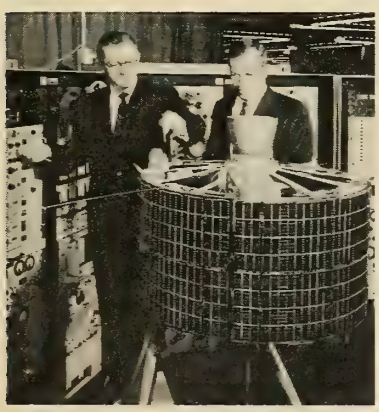
Earliest date for the launch is Feb. 13, 1963. If successful, the satellite will enter a 22,300-mi. orbit in which it will appear to remain almost stationary over a single point on Earth.

Syncom, built by Hughes Aircraft Co., is the third U.S. active communications satellite. It will be capable of transmitting only one two-way telephone transmission at a time, or several teletype messages. Unlike its predecessors, *Relay* and *Telstar*, it will not be able to handle television pictures.

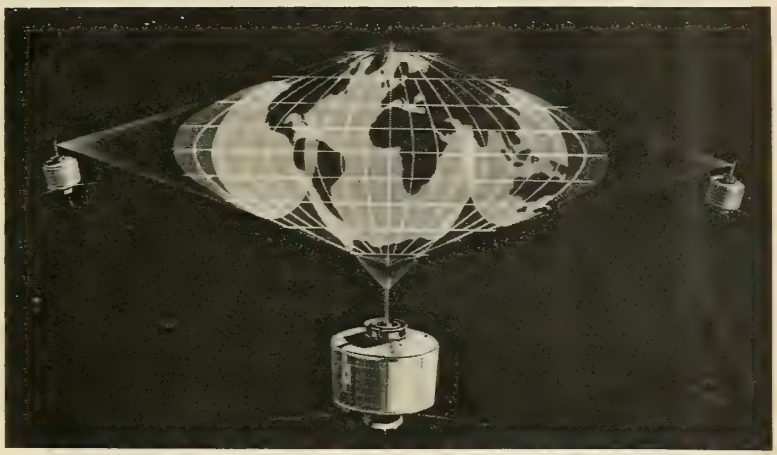
The satellite will be launched from Cape Canaveral into a highly elliptical orbit by the Douglas *Delta* booster, which has chalked up 14 straight successful missions. Upon reaching apogee, it will be kicked into the synchronous orbit by a solid rocket motor attached to the spacecraft.

Syncom will then hover at a fixed longitude over the Atlantic Ocean and move in an elongated figure-8 pattern approximately 30 degrees north and south of the equator.

Primary flight objectives, in addition to the synchronous orbit, are the testing of a control system to maintain *Syncom* in the prescribed orbit; communications transmission with a high-altitude satellite; and development of transportable ground facilities that can be deployed in useful areas when a ComSat system comes into operational use.



HUGHES Aircraft Co. officials shown giving final check to completed Syncom before it was delivered to NASA for launching.



HOW THREE stationary-type satellites in 22,300-mi. orbits will eventually provide a global communications network with uninterrupted TV and telephone service.

Syncom's entry into synchronous orbit is scheduled to take place over the Indian Ocean near Madagascar. The target position, however, is over the Atlantic Ocean between Africa and South America.

Moving it westward to the desired location will be the job of the spacecraft's hydrogen peroxide gas control system. The move to the desired longitude will take approximately two weeks, but communications testing may start as early as five days after launch.

The satellite will be maintained in its synchronous orbit by two nitrogen gas jet control systems. One will realign the satellite's spin axis so that it is perpendicular to the plane of the orbit. Another will fire to make corrections in orbital speed.

In its final location, the satellite will not be in a truly stationary orbit. This would require that the orbit be circular and in perfect alignment with the plane of the equator, and have a period of 24 hours. *Syncom* is designed only to meet the 24-hour requirements.

• **Goals**—In addition to the try for the 24-hour orbit, other firsts in the *Syncom* flight plan are the attempt to relay microwave signals from one point on Earth to another via a high-altitude satellite, and the first space communications link with Africa.

Syncom is a NASA project supported by the Defense Department. Thus far it has cost $20 million, which includes development of three satellites and three launch vehicles.

DOD will handle communication transmissions under NASA direction. Tests will be conducted between a transportable ground station at Lakehurst, N.J., and a station aboard the USNS Kingsport at anchor in Lagos Harbor, Nigeria.

Both were originally developed for use by the Army's *Advent* communications satellite system.

• **Details**—*Syncom*, without antennas or apogee motor, is a cylinder 28 in. in diameter and 15½ in. high. Weight of the spacecraft, including the apogee motor case with all the fuel gone, is 86 lbs. Payload weight is 150 lbs. at separation from the third stage of the *Delta* launch vehicle.

The side surface of *Syncom* is covered with 3840 silicon solar cells to supply energy to the nickel cadmium batteries.

Antennas include a slotted-array antenna for communications transmission, a dipole for communications receiving and four whip antennas in a turnstile arrangement for telemetry and command.

Syncom features backup electronic subsystems. Included are transponders with two travelling-wave tube transmitters and two receivers, either of which receivers may be used with either transmitter. One receiver has two narrow-band channels, each with a noise bandwidth of 500 kc. The other has a noise bandwidth of 5 mc. *Syncom's* receiver noise figure is 10 db; antenna gain is 2 db. ⌘

Budget breakdown shows . . .

Apollo Funding Stresses Fabrication

North American allotted $396.8 million, mainly for spacecraft; details of other top projects

by Hal Taylor

PROJECT *APOLLO's* Fiscal '64 budget provides for payment of $396.8 million to North American Aviation Inc. —most of it earmarked for fabrication of 14 copies of the three-man spacecraft.

In addition, NAA's many-membered Command and Service module contractor team will get $264.4 million.

Twelve development spacecraft and two for long manned orbital flights will be built. Work on other spacecraft will also be initiated to meet a Fiscal '65 delivery schedule of one man-rated vehicle every three months.

The program-wide trend from design to fabrication was revealed in an official NASA breakdown of its $3.1-billion manned spaceflight R&D funding request for the next fiscal year. There were these details of other major projects:

• Lunar Excursion Module funding of $230 million will initiate manufacturing of the first test vehicles, which will be flight-tested on *Saturn* and *Little Joe II* vehicles.

• Project *Gemini* funding of $306 million includes delivery of five flight spacecraft.

• A $47-million request for various launch vehicle technology studies is designed to provide the technical competence to initiate hardware development of *Nova* in Fiscal '65. This, of course, will depend on Kennedy Administration approval of funds for the giant booster.

• The $733-million request for the *Advanced Saturn* includes the delivery of several ground-test stages and a start on the fabrication of flight vehicles.

The heavy *Apollo* funding is designed to meet a launch schedule calling for module qualification flights in 1963-64, manned Earth-orbital flights in 1965-66, manned Earth-orbit rendezvous in 1966-67 and manned circumlunar, lunar-orbital and lunar-landing flights in the 1967-70 period.

Other major items in the $1.2-billion *Apollo* R&D budget include $130.7 million for the guidance and navigation system, $9.5 million for instrumentation and scientific equipment, and $135 million for procurement of *Little Joe II, Saturn* and *Saturn B* launch vehicles.

In addition to the spacecraft fabrication, part of the funds earmarked for NAA and its subcontractors will be used for intensive component and subsystem fabrication and testing and qualification of the Command and Service modules.

By the end of Fiscal '64, most spacecraft subsystems for manned orbital flight will have completed ground qualification testing. In addition, the abort and Earth-landing systems will be tested under simulated off-the-pad mission abort. Command and Service module propulsion system development tests will be conducted at White Sands Missile Range, N.M., and design of ground support equipment will be substantially completed and fabrication initiated.

LEM funding will also cover development of a throttleable rocket engine which will permit the spacecraft to hover above the lunar surface. Another model will be constructed and tests initiated to develop the LEM landing gear.

• **Guidance and navigation system**—Fiscal '64 funding will be used for development of prototype guidance systems and intensive ground tests will be conducted.

• **Instrumentation and scientific equipment**—Manned Spacecraft Center will design, fabricate, or purchase the equipment needed for eight *Apollo* flight tests and lunar-landing mission requirements.

Some of the needed equipment includes sensors, transducers, telemetry, transmitters, transmitting antennas, ground support equipment, cameras, TV systems, magnetometers, and seismographs.

• **Launch vehicles**—Four *Little Joe II* boosters will be procured, as well as long-lead-time items for additional vehicles. Six *Saturn* boosters will be obtained for manned orbital flights. *Saturn B* will be qualified in a long series of flights in Fiscal '66. The Fiscal '64 funds are for procurement of long-lead-time items needed for the first operational vehicles. The *Saturn B* flights with the entire *Apollo* spacecraft will permit NASA to schedule lunar missions with the first man-rated *Advanced Saturn* vehicle.

• **Project Gemini**—Fiscal '64 request for the two-man spaceflight program which will test orbital rendezvous techniques is $306.3 million. Some $196 million is earmarked for the spacecraft itself, with five to be delivered. Pro-

Official Breakdown of NASA $3.1 Billion Fiscal '64 RD&O Budget for Manned Space Flight (in millions)

	Fiscal '63	Fiscal '64
APOLLO	435.7	1,207.0
Spacecraft	350.1	1,031.4
Command Service	269.2	661.2
NAA Prime Contract	(160.8)	(396.8)
Subcontracts	(108.3)	(264.4)
Lunar Excursion Module	32.0	230.0
Guidance & Navigation	45.0	130.7
Instrumentation & Scientific Equipment	3.9	9.5
Operations	1.0	16.0
Launch Vehicle Procurement		
Little Joe II	4.5	5.0
Saturn	55.2	75.0
Saturn B	—	55.0
Supporting Development	5.0	25.0
GEMINI	232.8	306.3
Spacecraft	153.9	196.2
Operations	6.3	14.6
Launch Vehicles		
Titan II	59.2	46.9
Atlas	—	15.9
Agena	9.9	32.0
RL-10 ENGINE	32.6	32.6
Engine Development	22.3	25.3
Propellants	8.6	7.3
F-1 ENGINE	50.8	54.1
Engine Development	42.5	43.5
Test Equipment	—	—
Propellants	8.3	7.6
J-2 ENGINE	44.5	48.2
Engine Development	35.5	38.5
Test Equipment	—	1.4
Propellants	9.0	8.2
RANGE INSTRUMENTATION	—	20.0
Advanced Instrumentation	—	3.3
Design Data & Measurement	—	4.8
Instrumentation	—	—
Safety Instrumentation	—	3.4
Launch Support Instrumentation	—	3.8
Range Telemetry Expansion	—	4.5

curement of launch vehicles includes $46.9 million for *Titan II*, $15.9 million for *Atlas* and $32 million for the *Agena* target vehicle. Funding of $700,000 for supporting development will provide for continued development of the extra-vehicular suit, purchase of production pressure suits, development of "out-of-the-window" visual displays for the mission simulator and astronaut flight simulator training.

• **Advanced Saturn**—Total R&D costs for the big booster will hit $733 million in Fiscal '64. The $291.6-million request for its S-IC first stage will pay for assembly of the static-test stage and structural-test stage.

Fabrication of the dynamic test range will be completed and fabrication of two flight stages will begin.

A $181.4-million request has been made for the S-II second stage. This will include completion of fabrication drawings and procurement specifications. Assembly of static-test and dynamic-test stages will be completed. Fabrication of the first flight stage will begin in the current fiscal year, with Fiscal '64 funds paying for similar development of three more flight stages and procurement of long-lead-time items for two more flight stages.

The *S-IVB* Fiscal '64 development program calls for structural assembly of the first flight vehicle and fabrication of parts for the second and third vehicles. A ground-testing program will also begin. Total request for the one-J-2-engine stage is $82.3 million.

Over $69 million has been requested to purchase the liquid engines which will power the *Advanced Saturn*. Included is delivery of 10 F-1 engines and a start on procurement of long-lead-time items for 23 more. Fifteen J-2 engines will be delivered and a start made on long-lead-time items for 10 more.

• **Saturn B**—Development funding for the *Saturn B* booster will increase sharply—from $18.7 million to $68.6 million. A major part of the increase, $19 million, will be used to accelerate the testing program for the one-J-2-engine S-IVB second stage. The acceleration will cut one year off the original schedule.

The S-1 first-stage budget of $13.5 million provides for procurement of all structural and electrical items for the dynamic-test stage and the first two development-flight stages. Long-lead-time procurement for two other vehicles will also be initiated.

• **Saturn**—Funding for the *Saturn* booster will fall off sharply, from $190.7 million to $93.8 million. A request of $26.5 million for the eight-H-1-engine first stage and $25.5 million for the five-RL-10-engine second stage will be used primarily for engineering design improvement and delivery of the last vehicles for the R&D flight program.

• **Liquid engine development**—A total budget of $185.1 million has been requested for the liquid engine development program. Funding of $45 million for the M-1 liquid-hydrogen engine is not so high as expected because of delay in *Nova* development. The current schedule for the engine calls for major component testing to begin late this year, with engine testing in 1965. The preliminary flight-rating test is scheduled for 1967 and the qualification test for 1969.

Fiscal '64 funds are needed for engineering design, component design and fabrication, procurement of long-lead-time items and assembly of the first engine system for testing.

The other major engine development funding is the $45 million earmarked for the 1.5-million-lb.-thrust F-1 engine. It will be used to complete the preliminary flight rating test scheduled for early in the fiscal year. It will also pay for a follow-on development program designed to fulfill reliability standards for manned space flight. This calls for completely acceptable performance in 75 consecutive full-duration runs.

• **Launch vehicle supporting technology**—Other program areas are launch vehicle supporting technology, $16.9 million, and launch operations technology, $7.6 million.

Total funds requested for the next fiscal year for the support of the manned spaceflight booster program is $47 million. Studies of liquid and solid propulsion problems are expected to cost $22.5 million. NASA's solid technology program in Fiscal '64 will move to the subscale fabrication and testing stage. Included will be studies of shipping and handling networks, integration of motors into stage clusters, and definition of motor characteristics for various vehicle performance requirements.

• **Aerospace medicine**—Almost half of the total budget request in this area will be used for experimental studies. Slightly over $8 million will be spent on tissue radiation damage, emergency medical procedures for radiation exposure, shielding concepts which will reduce weight penalties, and instrumentation to indicate flux, energy, type and directionality of particles. Other work will be directed toward development of a self-contained life-support and suit-ventilation system, and the atmospheric composition of long-duration flights.

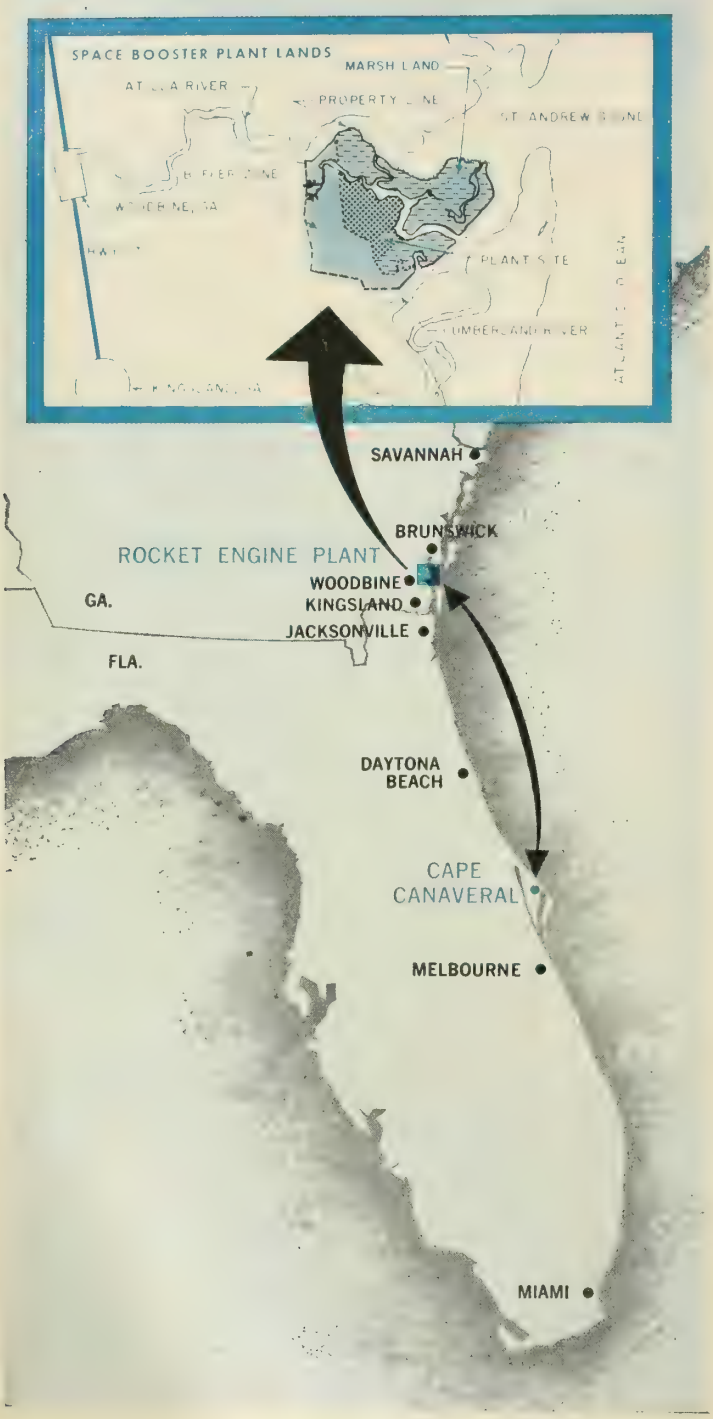
The $3.9-million budget for crew systems will continue already initiated development work and initiate new studies including development of an extra-vehicular-suit maneuvering device, a space garment, miniaturized equipment for in-flight medical care, and food.

• **Systems integration and checkout**—Almost all of the integration and checkout budget of $153 million will go to the prime integration contractor for the system, General Electric Co. Much of the $26 million earmarked for reliability assessment, however, will pay for work at NASA centers. Checkout equipment is needed mainly for the integrated launch control and checkout system.

• **Systems engineering**—The $37-million budget request will be used to fund study contracts involving the *Apollo* mission and such future missions as the manned lunar base, manned space stations, and manned planetary explorations. Studies will also be made of supporting projects such as the lunar logistics system and the *Nova* booster. ⌗

ADVANCED SATURN	328.6	733.0
S-IC Stage	144.5	291.6
S-II Stage	92.5	181.4
S-IVB Stage	32.1	82.3
Vehicle Instrument Unit	2.6	16.0
F-1 Engine Procurement	21.6	53.1
J-2 Engine Procurement	9.8	16.6
Support	14.5	75.0
M-1 ENGINE	35.0	45.0
Engine Development	23.1	33.3
Test Equipment	9.2	5.7
Facilities	1.2	—
Propellants	1.5	6.0
H-1 ENGINE	5.2	5.2
Engine Development	4.5	4.5
Propellants	.65	.7
Supporting Development	3.0	.7
Launch Vehicle Supporting Technology	8.8	16.9
Propulsion Supporting Technology	7.9	22.5
Launch Operations Supporting Technology	3.0	7.6
SATURN	190.7	93.8
S-I Stage	69.0	26.5
S-IV	43.7	25.5
Vehicle Instrument Unit	1.2	3.0
Guidance	12.2	2.0
H-1 Engine Procurement	7.9	2.0
RL-10 Engine Procurement	12.6	3.4
System Integration	43.8	30.6
SATURN B	18.7	68.6
S-IB Stage	3.6	13.5
S-IVB	10.0	19.1
Vehicle Instrument Div.	—	—
Guidance System	—	5.2
H-1 Engine Procurement	1.7	3.7
J-2 Engine Procurement	2.0	4.2
System Integration	1.4	16.9
RANGE SUPPORT	8.0	21.0
AEROSPACE MEDICINE	7.0	16.7
Experimental Studies	2.9	8.1
Crew Systems	3.6	3.9
Biomedical In-flight Experiments	.25	3.1
Medical Operations	.2	1.5
INTEGRATION & CHECKOUT (primarily GE contract)	38.5	153.0
Integration	6.0	26.0
Checkout	26.5	101.0
Reliability Assessment	6.0	26.0
SYSTEMS ENGINEERING AND STUDIES	26.5	27.0
PERSONNEL & INSTALLATION COSTS	—	361.0

THIOKOL SPEEDS CONSTRUCTION OF MULTI-MILLION DOLLAR SPACE BOOSTER PLANT IN GEORGIA



Plant, designed for large solid space boosters, located only 170 miles from Cape Canaveral

Thiokol is stepping up construction of its space booster plant in Camden County, Georgia. First phase of construction, to cost more than $10 million, is due for completion early in '64.

The Thiokol facilities group, who was responsible for design and construction of Air Force Plant 78 in Utah, is now working at the plant site establishing design criteria. The architectural and engineering firm of Mason-Rust which is providing design details has also set-up offices nearby.

The space booster plant site is located in an area of 50,000 uninhabited acres readily accessible by rail and highway for delivery of inert components. It is located directly on the coastal inland waterway providing clear water-borne transportation to Cape Canaveral' launching complexes. The large expanse of water bordering the area enlarges the buffer zone. This area is sufficient for production and test of motors of more than 10 million pounds of thrust.

Construction will include a casting pit 50 feet in diameter and 120 feet deep, fully equipped for casting, curing and static testing. Propellant mixing buildings incorporating an automated batch mixing system will also be constructed.

Behind the design, development and operation of Thiokol's space booster plant are the solid rocket technologies proven by Thiokol in existing missile systems... proven capable of producing powerplants of maximum performance at minimum cost in time and dollars.

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Rocket Operations Center: Ogden, Utah
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Technical Countdown

ELECTRONICS

Philco Wins Houston Center Work

System designer and integrator for the NASA's new Houston spacecraft control center will be Philco's Western Development Laboratories, Palo Alto, Calif. Under a $30-million contract announced last week, Philco will design, develop, and integrate the "Integrated Mission Control Center," which will be required for both the *Gemini* and *Apollo* manned space programs. The center will include all necessary communications, displays, and simulation and training equipment—expected to cost about $18 million. IBM will supply both an interim and final real-time computer complex under an award announced last October. Total cost of the center is expected to exceed $50 million.

New Defender Contract Awarded

AF Systems Command has contracted with Geophysics Corp. of America, Bedford, Mass., for a study of new optical techniques that might be used effectively in sorting ballistic missile warheads from decoys. First phase of the classified $500,000 study is already under way in the firm's Physics Research Division. Experimental work will be done at the AF Arnold Engineering Development Center, Tullahoma, Tenn. The study is part of DOD's Project *Defender*.

Telemetry Amplifier Designed for Spacecraft

A voltage-tunable microwave-oscillator and travelling-wave amplifier tube, designed to handle telemetry requirements aboard a space vehicle, has been developed by Watkins-Johnson Co. under Air Force funding. Tests show the amplifier function can attain an efficiency higher than 20% when depressed collector techniques are employed. A unique support allows the use of a bifilar helix with large voltage difference between the helices while low voltage gradients are maintained along the surface of the insulators in the vacuum. A conventional, convergent-flow electron gun is used.

Stanford Accelerator Progress

Stanford University scientists hope to move next month into the first major building of their two-mile linear electron-accelerator complex. Dr. Richard B. Neal, associate director of the project, reported to the American Physical Society meeting in New York that completion of the $114-million atom smasher is scheduled for 1966, full-scale research operation one year later. Installation of the first accelerator components is expected to begin in 14 months. Completion of the first 333-ft. section of the accelerator housing and the 240-tube klystron gallery is expected in March, 1964.

GaAs Diodes See Heavy Emphasis

Recently achieved stimulated emission of energy in gallium-arsenide diodes drew considerable attention to the devices and their laser applications at the recent American Physical Society meeting. IBM scientists, who delivered three of the 10 papers on the subject, called for further investigation to perfect laser structures as the key to improved CW operation. A recent IBM-developed CW device is a rectangular parallelepiped, with a p-n junction parallel to the long dimensions of the crystal and located centrally. IBM reports that experiments with pulsed operation at room temperature indicate the threshold for stimulated emission is about 10 times larger than at 77°K. Studies of the spatial origin of light clearly show, the company says, that light in high-efficiency units comes from the p-region. It was found also that in a rectangular-parallelepiped laser the appearance of the emitting region does not change as the current is increased above threshold for stimulated emission.

NATO Pressing for Miniaturization

The NATO Advisory Group for Aeronautical Research and Development (AGARD) has recommended establishment of a lecture series on "Micropower Electronics." The group is reported to be concerned over currently excessive size and weight of electronic equipment for space use. The Consultant and Exchange Programs of AGARD will sponsor a two-day program this June in at least three NATO countries, dealing with the philosophy, design and operation of microelectronic circuits at minimum power levels.

ASTRONAUTICS

Radio Galaxy Theory Advanced

Dr. William A. Fowler, Cal Tech physicist, has reported to the American Physical Society on the hypothesis which he and Dr. Fred Hoyle of Cambridge University, London, are advancing to explain the enormous energy requirements of the so-called "radio galaxies." Citing observations at Cal Tech's radio observatory, Fowler and Hoyle assert that gravitational energy from the collapse and resulting explosion of "super super novae" stars—from 1-10 million times the mass of the Sun—may provide the energy apparently required by these galaxies.

PROPULSION

Attitude Rocket Hits Record Firing

Marquardt Corp. has fired a chemically fueled attitude control rocket for 17 hours, 22 minutes in what is believed to be the longest continuous firing of such engines on record. The unit is rated at 0.2 lbs. thrust and is radiation-cooled.

More Titan III Subcontractors Notified

Nozzles for the 120-in. strap-on solid boosters for the *Titan III* will probably be manufactured by both H. I. Thompson Fiber Glass Co. and the TAPCO Group of Thompson Ramo Wooldridge Inc. Thrust-vector-control components will be separate, with Ling-Temco-Vought handling the injector valves and the Hamilton-Standard Division of United Aircraft providing the electronics. The tank-pressurization-subsystem subcontractor has not yet been selected.

ADVANCED MATERIALS

Si Crystal Diameters Increased

Development by Dow Corning Corp. of float-zone-refined single-crystal silicon with 40-mm-dia. crystals may lead to significant improvements in electronic power devices and communications circuits. Dow claims the process will permit increase from current maximum silicon slice size of 25 mm dia. and still maintain uniform resistivity properties and high purity. Large-diameter slices have been produced by other methods, but only at the price of reduced uniformities and purity. Main advantage for high-power rectifiers and rectifier-control devices will be increased current rating, possibly to 1000 amps.

Androforming Process Comes of Age

Wyman-Gordon's adoption of die-less metalworking method is generating a thriving business in aerospace field

by John F. Judge

A LEADING missile/space closed-die forging firm is moving into the sheet-metal forming field with the most gentle metalworking process known.

Wyman-Gordon Co. holds a controlling interest in Androform Industries, Inc.—originators of a unique sheet-contouring method capable of working the most exotic alloys at room temperature.

The process, called Androforming, produces compound curvature in flat sheet metal without the use of dies, through differential elongation. With Androforming, the lack of tooling investment on any given production run results in a highly economical, low-quantity output capability.

Invented 15 years ago by Frohman Anderson, the process was often oversold in its early years of existence. The current marketing set-up involves both Androform and Wyman-Gordon sales engineers. The present realistic approach is generating a thriving business in radar reflectors, airframes and other aerospace sheet metal applications.

The Air Force owns an Androforming machine capable of handling metals up to 9/16 in. thick. The machine, part of an overall production research effort under Air Force sponsorship, is located at the General Dynamics/Fort Worth plant. Among other units sold, one purchased by a French aircraft firm has been credited with seven years of operation with no down-time.

Androforming's metalworking ability is so gentle that company engineers say they have formed and re-formed the same piece of metal up to 25 times without affecting the original physical properties. The last of these forming operations produced a part well within required tolerances.

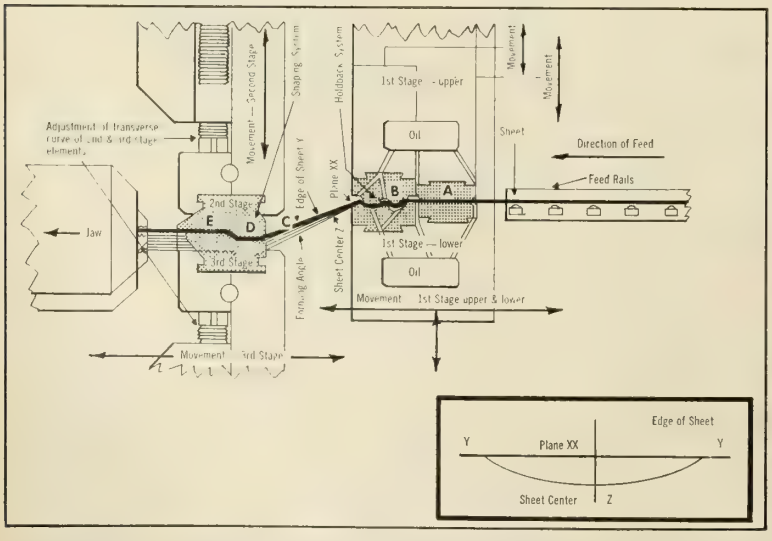
The desired contour in any given application is analyzed by Androform engineers and translated into process-element curvature and machine settings. In a normal run, 85-90% of the final shape is usually achieved in the first draw. Any combination of curves can be attained in a single or double draw, and specific limitations can be determined before any metal is moved.

Androforming imparts the actual dimensional change-per-unit area that a flat blank needs to create a contoured part as the blank moves through the forming stages.

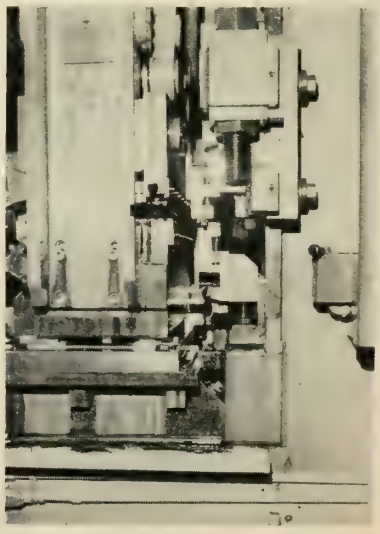
• **Minimum waste**—All other forming methods place the entire blank under a tensile load just below its ultimate tolerance point to effect permanent deformation. Androform experts—admittedly oversimplifying to make their point—say this marginal factor contributes to high waste, scrap and imperfections in stretch or die-to-die forming. The inability to apply variable stresses on selected portions of a blank is another contributing factor.

Activation and control of various components in the Androform machine causes the desired deformation by low-stress application. This application of stress is imparted at any one instance to only an infinitesimal portion of the workpiece.

The application of controlled variable stresses exactly where needed and in the precise amount necessary results in panels with even stress distribution. The physical properties of the con-



OPERATIONAL schematic of Androform machine illustrates the modes of element movement together with passage of workpiece through the unit.



ACTUAL GAP between stages one and two-three of Androform device.

toured product are essentially the same as in the original blank.

In addition to the drastic reduction in scrap level, Androforming eliminates the need for stretcher leveling prior to forming. The absence of spring-back in the finished panel insures exact duplication in successive pieces.

• **Three parts**—The Androform machine has three basic sections—the feed table, the forming section and the drawing or propelling section.

The feed table is a platform supporting the flat blanks as they are drawn through the machine. The propelling device is a draw bench with a set of jaws accommodating the maximum-width sheet handled by the machine. These jaws are adjustable to a curvature similar to that set into the forming stages.

The forming section is divided into three separate stages. The first stage has precision-ground beads on nesting upper and lower components. The lower part acts as the female member—having two grooves and three lands. The lands and bases of the grooves are cut to a definite radius for each range of material thickness. The end view resembles that of a corrugated sheet. The upper male section mates with this part.

This stage provides tensile loading —or sheet restraint—with the amount of loading controlled by the gap between the two sections. This gap—measured as the distance between the lowest point of the upper section and the highest point of the lower section—normally is set as a percentage of metal thickness.

The second stage is a hardened tool-steel element flexed to a predetermined curve by means of adjusting clamps.

In operation, a sheet is placed on the feed table and fed through the three stages with the first-stage upper element and the second stage open. Partially closing the second stage curves the lead portion of the sheet, allowing it to enter the clamping jaws, which previously have been adjusted to the transverse curvature of the second- and third-stage elements.

• **Forming procedure**—The machine then cycles through the following operations (see diagram):

—First and second stages close to predetermined gaps, and jaw carriage is activated. Pressure plates lubricate and prevent buckling.

—Forming element inserts (B) restrain the material, placing the blank under a tensile load.

—Material passes through second- (D) and third- (E) stage elements. Pre-adjusted contour of these elements is a computed proportion of the mean of the variable tranverse contour desired in the panel. This does not change during the cycle.

—In path (C) through (D), the material passes from a plane surface to a curved surface, causing elongations in small increments only where required. Elongation is maximum at the deepest part of the contour—decreasing progressively until little or no elongation occurs at the edges of the blank.

In the small line drawing, the straight line labeled "Plane XX" represents the first stage, and the curved line "YZY" the second stage. The distance between these two lines is greater at point "Z", of course, than it is at point "Y".

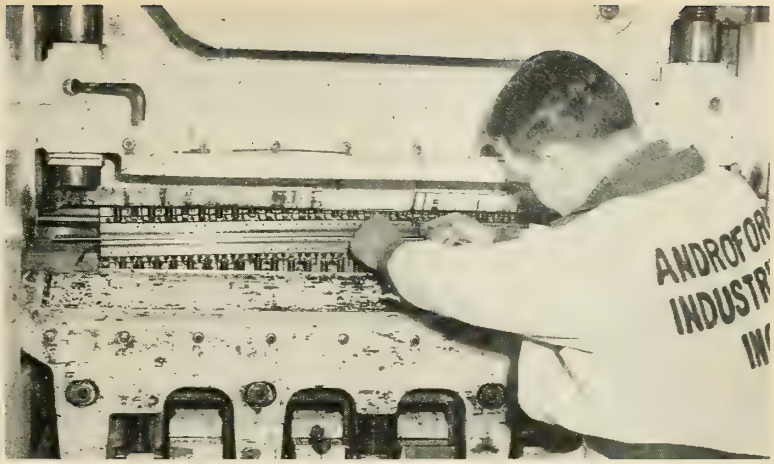
The sheet obviously cannot travel faster at point "Z"—so it produces an elliptical pattern of elongation, resulting in curvature in both the width and the length of the sheet.

Variations in curvature of the sheet depend upon the distance of the first stage from the second stage. Moving the first stage closer to the second and third stages increases the forming angle, causing greater elongation of the material and increased curve. Moving the first-stage elements away from the curved second and third stages decreases the forming angle and the resultant curve. Both actions permit variable curves and greater contour in the panels than that of the adjusted second and third stage elements.

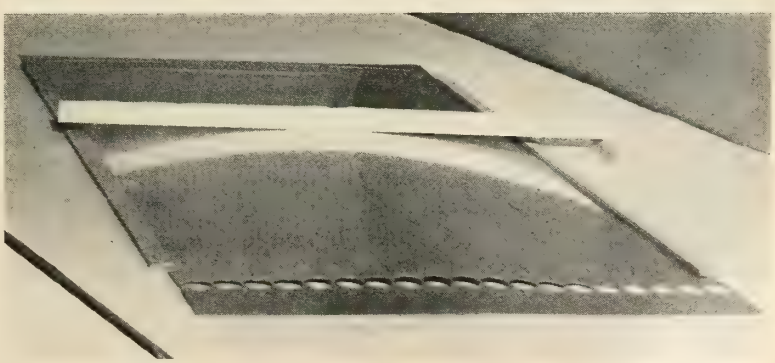
Thus, there are three factors influencing the amount of curvature imparted to the blank: the amount of restraint or tensile load imposed by the first stage; the curvature set into the second stage element; and the distance between the first and second stages.

Lateral movement of the third stage controls the longtitudinal presentation of the formed panel. Closing the gap betwen (E) and (D) will cause the panel to curve down, while the opposite action will produce coiling upwards.

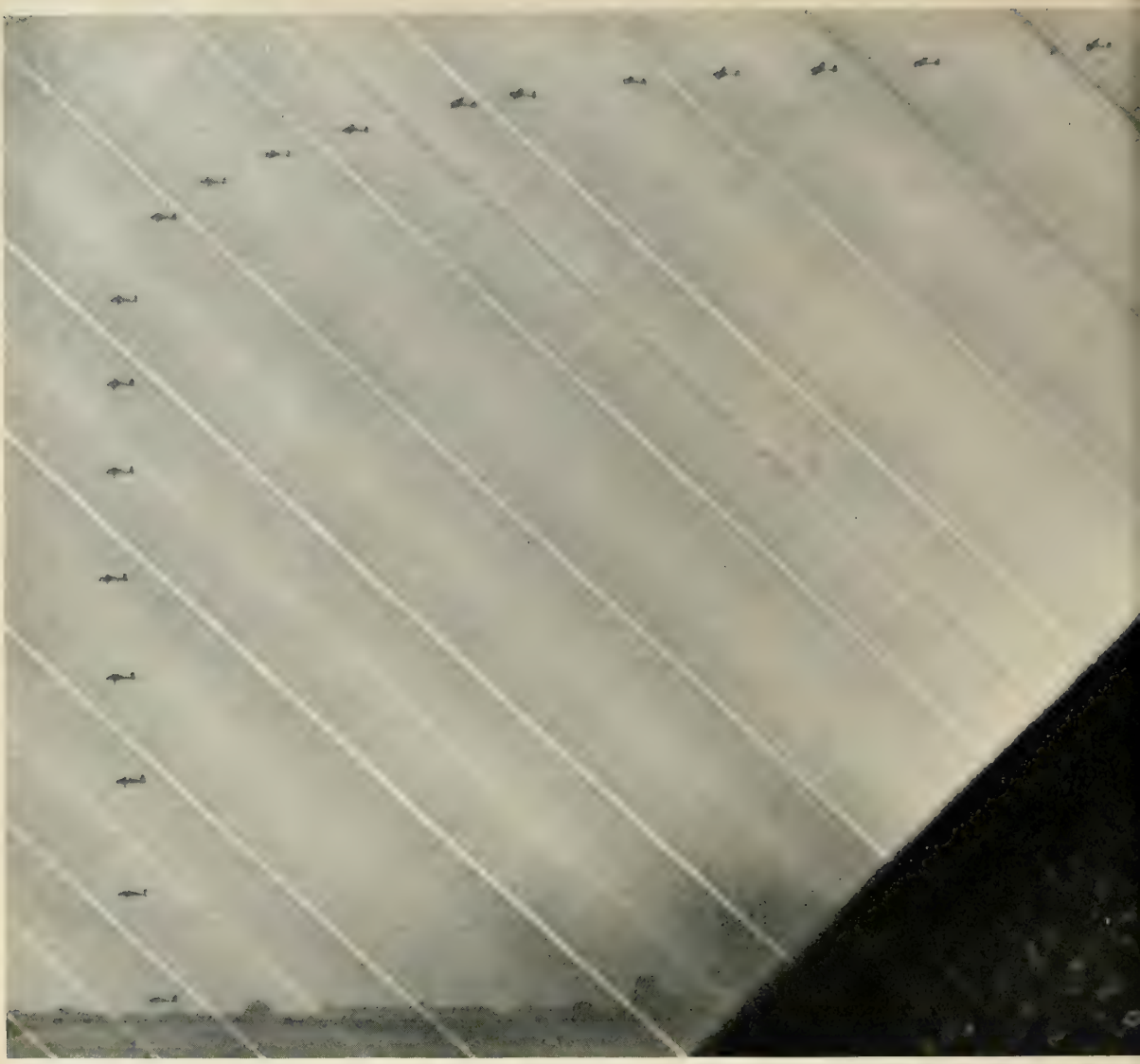
This is a control of the presentation of the blank in space only. The true surface map is formed by the prior occurring actions. For example, the third stage can be so adjusted as to present the panel as a coil. When the panel is unrolled and the four corners pinned down on a plane surface, the true compound variable contour formed in the panel by the applied stresses will be revealed. ⁂



CURVATURE is set into second stage by flexing a tool steel element through a series of adjusting screws. Tool wear is negligible.



EXTREMELY GENTLE nature of Androforming process is demonstrated by forming a flat sheet with stock removed just ahead of clamping screws.



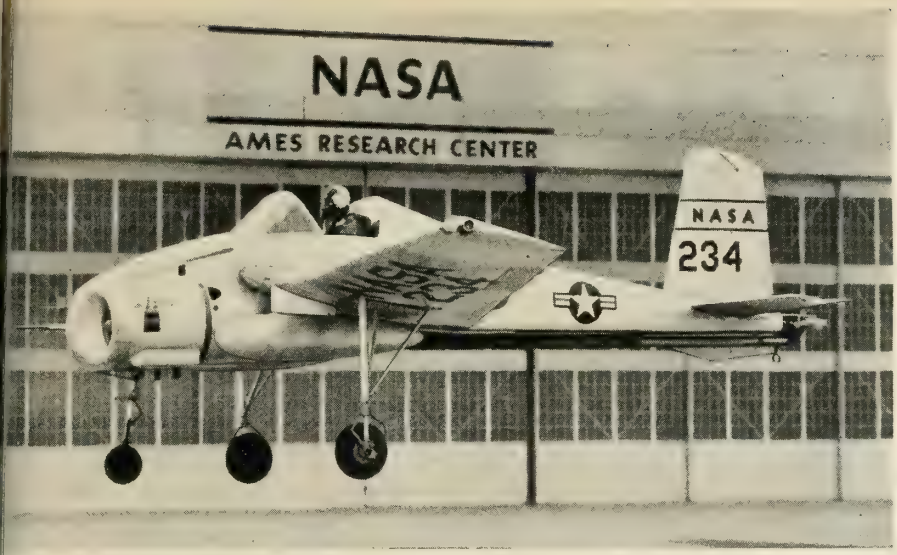
V/STOL U.S.A.

This is a flight analyzer record made at NASA's Ames Research Center in Augu 1962 showing a transition from conventional flight at an 800 foot altitude throu a vertical descent to landing.

The plane is a Bell X-14A VTOL. It is a modified version of the historic X-14, t first jet-powered horizontal attitude VTOL craft to take off vertically, transition normal horizontal flight, and then hover and land vertically.

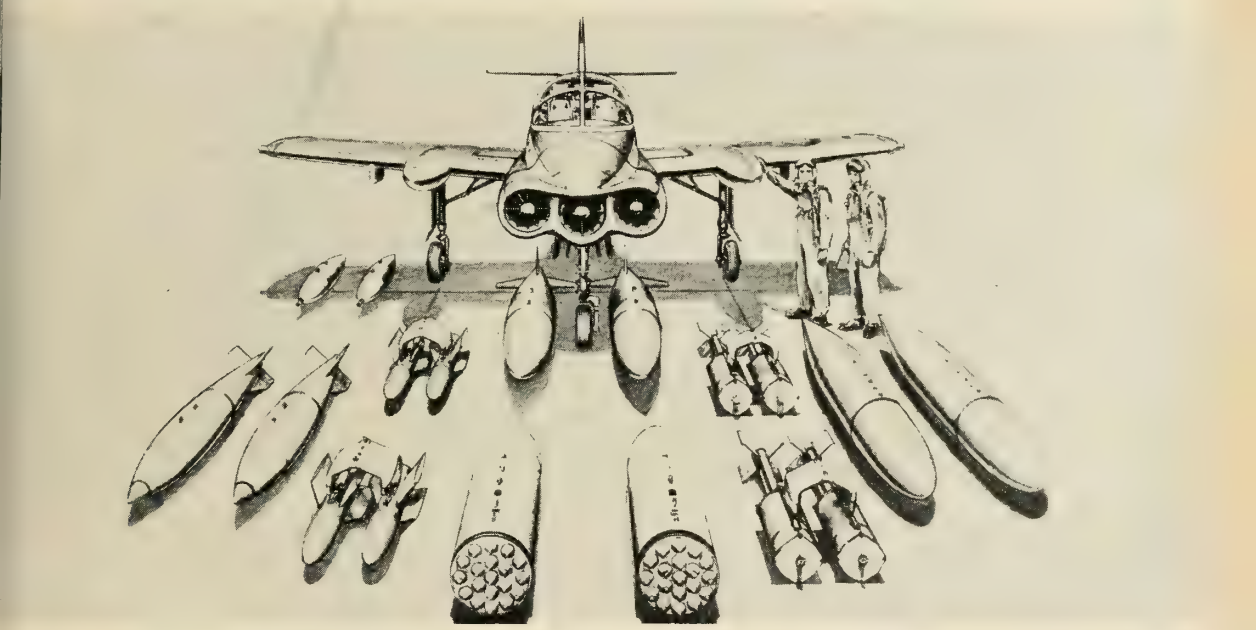
Bell built and flew the original X-14 research airplane for the U.S. Air Force. It ma its first hovering flight in 1957, its first complete transition in May 1958. In 19 it was transferred to NASA's Ames Research Center where it has been in active flig test service in NASA's VTOL evaluation and research program.

Fortunate, indeed, that Bell pioneered this highly practical and successful VTOL a plane. For now we have a proven trainer for the pilots who must be trained to fly t VTOL aircraft which are now under consideration for military service.



A VTOL TRAINER READY...NOW

The Bell X-14A is the only *two-place* jet VTOL presently being flown anywhere in the world. This aircraft has been in active flight testing for over five years . . . is still in operation at NASA's Ames Research Center. Versions of this plane are ready for use as VTOL pilot trainers or as limited warfare close support aircraft.



THE X-14C LIMITED WARFARE CLOSE SUPPORT AIRCRAFT

is aircraft is based on the original X-14 machine and uses three engines with thrust diverters. The increased rust available from this lightweight propulsion system is used with the same proven X-14 control system to oduce a rugged aircraft designed to combat aircraft load factors. The high thrust to weight ratio of these small -the-shelf power plants combined with Bell's thrust diverters provides the most efficient propulsion package of y jet V/STOL concept. This affords the design of small two-place combat aircraft with considerable armament pability and radii. Provisions are available for machine gun pods, air to surface missiles, unguided rockets and variety of other disposable externally mounted stores.

BELL AEROSYSTEMS COMPANY • *P. O. Box 1, Buffalo 5, N. Y.*
DIVISION OF BELL AEROSPACE CORPORATION

A textron COMPANY

Now Honeywell offers engineers an opportunity to get in on the ground floor of its Space & Missile Systems Group

Several years ago, we formed the nucleus of our Space & Missile Systems Group. Its assignment: to originate ideas for new missions, define their feasibility and determine how to accomplish them.

To make this group successful, we obviously needed the exceptional engineer. More specifically, we agreed that only around one engineer in X,000 had the experience and ability needed for such demanding work. This decision paid off.

Our young Space & Missile Systems Group has proven so valuable on vital projects such as Apollo that we believe it is one of the most important keys to our future growth.

Because of its fine record, we're ready for another step—adding the handful of experienced systems engineers whose ideas and talents will help create a breakthrough to even bigger things.

To these few engineers, we offer the opportunity to get in on the ground floor of a specialized group that's just starting to realize its potential.

Maybe you're one of these men? Maybe you're not?

You'll have to be a real pro. You can tell this from the qualifications at right. But there's more to it than that. You'll have to spark others with suggestions and ideas. Take charge of your end and follow through without *any* supervision.

You'll have to be human, too. Big enough to shoulder some of the blame when little things go wrong. Big enough to pass along some of the credit for success.

On the other hand, we expect you to take some time to get your feet on the ground. We'd be delighted, of course, if you could come up with some brilliant ideas your first week or so. But we admit that this would be asking quite a bit.

You'll have to enjoy variety. Some engineers don't like change. If you feel this way, you'd be unhappy from your first day on. In our Space & Missile Group, variety isn't the exception . . . it's the *rule!*

You'll have to earn your own way. As you might suspect, our starting salary for such specialized work is quite liberal. But from then on, it's up to you. We pay on merit only. *You* set the rate at which you advance. This applies to promotions, too. We'll move you ahead as fast as you can handle the work. Frankly, this is as much to our advantage as yours. As far as fringe benefits are concerned, we have retirement, insurance, stock purchase plans . . . and all the rest.

You'll have to work hard. This job is anything but a snap. We'd be dishonest if we didn't tell you now. Most of the engineers in our Space & Missile Systems Group put in occasional nights and weekends. You probably will, too. In addition, it would be unusual if you didn't find yourself up against problems that would keep you awake more than one night.

What we would like from you . . . now. We've briefly covered a few of the advantages (and what some may consider disadvantages) of joining our Space & Missile Systems Group. If you meet the requirements at right and want to learn more, we'd appreciate hearing from you immediately.

There's no need to send a detailed resumé, however. Just mail a brief list of your qualifications along with a rough idea of your salary requirements to:

Richard A. Friedrichs
Honeywell, Aeronautical Division
2604 Ridgway Road
Minneapolis 40, Minn.

He'll contact you personally. Your inquiry will be held in strict confidence.

Honeywell

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Key positions open now in Honeywell's young, vigorous SPACE & MISSILE SYSTEMS GROUP

You must be experienced and oriented in prime systems. At present, systems are satellites, small to medium sized missiles plus integration of major electronic sub-systems into total systems.

If you have your Engineering B.S. and at least five years' experience, we suggest you contact us for possible openings in your specific field. Jobs listed below are typical of those now open.

OPERATIONS ANALYSIS

Section Head—(MS Eng.), 8-10 years' experience. Responsible for aerospace warfare study, concept formulation and evaluation of optimum weapons and vehicles to meet future needs.

Staff Engineer, Operations, Analysis—(MS Eng.), 6-8 years' experience. Responsible for developing, presenting and justifying total weapons systems.

FLIGHT TECHNOLOGY

Section Head—(BSAE), 10 years' experience in analytical field of weapon development. Responsible for areas of Performance, Aerodynamics, Thermodynamics, Space Mechanics and Trajectory Analysis.

PROJECT MANAGEMENT

Staff Engineer—Armament Systems—at least 10 years' experience in airborne armanent systems. Manage advanced design programs in missile systems and avionic armament equipments.

Staff Engineer, Electronics—(MSEE), 8 years' experience in electronics systems including guidance, controls, radar, instrumentation. Responsible for making decisions, getting jobs done.

If you meet qualifications in these areas, write Mr. Richard A. Friedrichs. See address at left. He will contact you personally.

Honeywell

To explore professional opportunities in other Honeywell locations, coast to coast, send your application in confidence to Mr. H. G. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

An equal opportunity employer

Spaceborne Radar Aimed At Rendezvous Guidance

Raytheon tri-mode system may benefit NASA, military

by Michael Getler

BEDFORD, MASS.—Engineers at Raytheon's Missile and Space Division here have completed design of a tri-mode spaceborne radar system for use in rendezvous with either cooperative or non-cooperative space vehicles.

The system is aimed at three basic missions, with some overlap which could make it applicable to both NASA and military programs. The missions envisioned are: 1) a basic cooperative rendezvous between a radar-equipped and a transponder-equipped spacecraft, 2) a rescue mission joining a radar-equipped craft with a friendly but non-cooperative passive vehicle (possibly augmented with a corner radar reflector), and 3) rendezvous with a hostile vehicle that can take evasive action.

Functional sensor requirements for these missions were investigated using the Raytheon fixed-base analog orbital rendezvous and extra-terrestrial landing simulator. This unit is used to determine inputs required from sensing equipment for both automatic and manual control of rendezvous in particular vehicles.

Though a complete tri-mode system has been designed, Raytheon has bread-boarded and made lab demonstrations primarily with the basic radar/transponder cooperative system. Equipment for the additional capabilities is technically within reach, but would require some additional development for this task.

Geoffrey Bonelle, special projects director at Bedford, says that designing for the third and most difficult capability—non-cooperative rendezvous—makes it relatively simple to adapt the system to fulfill the other two missions, thus providing a complete capability in a single package. In terms of equipment requirements, he adds, "80% of what's needed for tri-mode operation is included in the basic cooperative system."

• **Hawk inputs**—Some of the techniques Raytheon used in adding the hostile-target and rescue-mission rendezvous capability reportedly are similar to the company's design of the ground-based tracker-illuminator radar used with its *Hawk* surface-to-air missile system.

The basic radar/transponder cooperative system is a solid-state, fully coherent FM/CW unit which operates at X-band. Bonelle says use of FM/CW allows velocity measurements to within small fractions of 1 ft./sec., and range

TABLE I—Cooperative radar/transponder system characteristics

Transponder wt. (solid-state)	less than 6 lbs.
Transponder power consumption	20 watts
Transponder reliability MTBF	30,000 hrs.
Radar wt. (solid-state)	20 lbs., including antenna
Radar power consumption	50 watts, including servo no load loss
Transmitter output	½ watt
Radar reliability MTBF	13,000 hrs.
Range accuracy	± 2 ft.
Velocity accuracy	0.1 ft./sec.
Angular accuracy	0.3 mr
Maximum range	200-400 n. mi. (With 12-in.-dia. antenna at X-band)
Minimum range	5 ft. (With 12-in.-dia. antenna at X-band)

TABLE II—Non-cooperative rescue system characteristics

Transmitter output	7 watts
Receiver noise figure	9 db
Acquisition range	20 n. mi.
Scan angle	± 60 deg. each plane
Input power (klystron)	150 watts, excluding servo power
Weight	40 lbs., including antenna
Reliability MTBF	10,000 hrs.
Range accuracy	± 2 ft. at close range
Velocity accuracy	0.1 ft./sec.
Angle accuracy	0.5 mr at medium ranges (1000 ft.)
Antenna size	2-ft.-dia. (2 elliptical antennas with a 2-ft. dia.)

TABLE III—Tri-mode system characteristics

Transmitter output	70 watts
Weight	45 lbs., including antenna
Power consumption (amplitron)	150 watts, excluding servo power
Reliability MTBF	13,000 hrs. (station keeping) 3000 hrs. (acquisition)
Radar size, excluding antenna	1 to 1.5 cu. ft.



RAYTHEON ORBITAL rendezvous and extraterrestrial landing simulator used to determine sensor functional requirements for space mission is illustrated here.

measurements to within a few feet even at extremely close-in distances. Raytheon, which pioneered in the development of FM/CW systems, chose this technique for tri-mode operation after also studying both non-coherent pulse radar and high-duty-cycle pulse-Doppler devices.

The firm is also known to have proposed to NASA similar radar designs, using some of the techniques discussed here, to meet sensor needs for the Lunar Excursion Module.

Applications for these designs, they report, are in both rendezvous and landing phases of the LEM mission, with integration of the radars within the overall guidance and navigation system being of prime design consideration.

Bonelle and Project Director George Grant estimate that a prototype radar/transponder system would reflect physical and performance characteristics as illustrated in Table 1 on page 27, though the currently operating lab model made with conventional components is somewhat larger and heavier.

The engineers also say a new torsion-suspension antenna gimballing method is used, and that the firm's Machlett Lab Div., through work with X-ray tube bearings, has evolved new methods for bearing lubrication in space.

• **System operation**—In the radar/transponder system, velocity is measured by the Doppler shift of the carrier frequency, and range is measured by the phase shift of the modulation sidebands in a fine-and-coarse scale system. Angular data is obtained in the conventional manner from the tracking antenna. Since the transponder shifts the carrier frequency received by a known amount, the classical transmitter/receiver isolation problem with CW systems does not arise, Bonelle and Grant report, and a common antenna can be used.

To add the non-cooperative rescue mission capability requires several system modifications, including use of a high-power amplifier tube. Many of these changes also contribute to achieving the hostile-target rendezvous capability.

In the case of rescue of friendly spacecraft that are either inherently passive or have had an on-board power failure, engineers assume an effective target area of 40 sq. meters (either through basic design or augmentation with corner reflectors). It is also assumed that ground command can direct the craft to a point roughly 20 miles from the other vehicle for start of the terminal phase.

Removal of the transponder from the link means both increased radar sensitivity and a solution of T/R isolation problems, since transponder frequency shifting is no longer available. To meet these needs, four basic changes are made: 1) transmitter power is increased, 2) a larger antenna is used both to increase sensitivity and to deal with isolation problems, 3) a single-sideband generator is added to supply local oscillator power, and 4) acquisition system is enhanced through addition of a detection filter bank.

The characteristics of the radar with the rescue capability are shown in Table II.

• **X-Band amplitron use**—The rescue mission system, as outlined, is actually based on use of either a klystron or traveling-wave-tube with additional microwave switching circuitry. Amplitrons are now available at X-band, Grant says, and "data are at hand that would enable the minor tailoring of existing amplitron designs to the appropriate frequency and power level."

Raytheon does manufacture an S-band (QKS-997A) amplitron which reportedly yields about 20 watts and operates at a minimum 60% efficiency (M/R, Jan. 7, p. 23). Grant, who claims similar high efficiencies are possible for amplitrons at X-band, also points out that replacing the klystron or twt with an amplitron in the rescue configuration would yield an additional 10-db improvement in performance with the same input power.

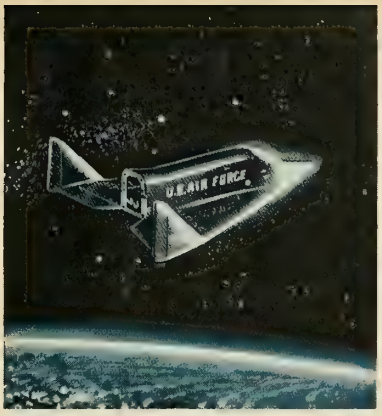
To add the third mode—rendezvous with an assumed 1-sq.-meter hostile target—both Bonelle and Grant report an estimated 16-db sensitivity improvement is needed. This is achieved in minor part by use of a parametric amplifier to reduce system noise and to a major degree by raising transmitter output to 70 watts. (See Table III for tri-mode system characteristics.)

Bonelle says the increased power output does not cause a corresponding increase in input power due to efficiencies possible with higher-power amplitron devices. "By scaling an amplitron from existing design at different power levels or different frequencies," he reports, "an output power improvement of 10X can be obtained without noticeable increase in input power."

Actually, engineers point out, the amplitron power is required primarily during the acquisition and early tracking phase—a period which is relatively short due to closing speeds of about 500 ft./sec. The amplifier stage is not needed at all during the close-range station-keeping phase, which allows the high-voltage power supply to be shut off in favor of the lower-power solid-state system. An amplitron is convenient for this application, they report, since it acts as a transmission waveguide allowing driver output to propagate through the device with total attenuation of about 0.5 db by merely removing the anode voltage. ⁂



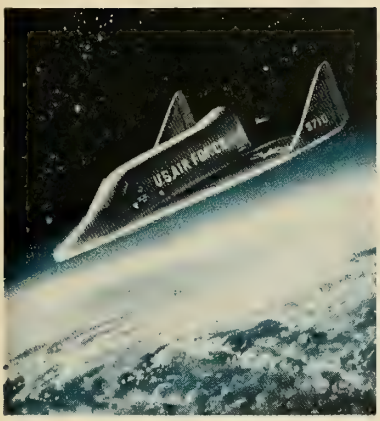
Acquisition



100 miles



in space...



dissipation



of 30 billion foot-pounds



of energy...



guidance



precisely through



the needle's eye

Command Recovery. Terminal control and landing of spacecraft...energy management, data links, cockpit displays for aerospace missions. These are not just "long-range objectives" at Sperry Phoenix. For example, we are under contract with USAF Aeronautical Systems Division to capture the X-20 Dyna-Soar vehicle upon re-entry from space, then manage its let-down and landing. This will be done with Sperry microwave guidance and control equipment existing today. We believe we can excel in this USAF assignment because it represents a logical extension of years of Sperry Phoenix experience in high-performance pilotless flight... experience greater in depth and breadth than that of any other company. We welcome new challenges in these and related fields. *SPERRY PHOENIX COMPANY, Phoenix, Arizona.*

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NASA Bioscience Duties Pinpointed

Space agency's definition of responsibilities aimed at elimination of duplication among related offices

by Heather M. David

NEW YORK—NASA's three offices with bioastronautics interests have publicly defined for the first time their roles and interrelationships.

The presentation showed the agency's strong effort to eliminate any duplication or wasteful effort for which it had been criticized in the past.

Three NASA scientists last week forecast to an IAS audience these future programs for organisms ranging in complexity from amoebae to primates to man:

—Orbiting of a primate for more than 14 days in a sea-level, two-gas-atmosphere capsule, with deep brain probes, cardiac output implants and other sophisticated instrumentation.

—Orbiting of a primate for three days with a gamma-radiation emitter of the 10 to 20 Curies range—two roentgens per minute.

—Experiments to see if high magnetic fields will create "lasers" inside man's body.

—Search for better bioinstrumentation and sensors by all NASA offices.

The programs will be administred by three NASA offices: Manned Spaceflight, Biotechnology and Human Research, and Space Sciences.

[See p. 14 in this issue, and related articles in coming issues of M/R for the budget breakdowns in 1) Aerospace Medicine—Manned Spaceflight, 2) Bioscience Programs—Space Sciences and 3) Biotechnology and Human Research —OART].

• **Manned Spaceflight**—The Office of Aerospace Medicine in this office has the job of: a) operational support for, and b) conducting development and tests of systems and components to insure effective performance in manned spaceflight.

Basically, said Dr. Joe A. Connor, assistant director of this office, existing technology can meet the challenge of spaceflight through the *Apollo* mission. However, a few thorny areas need to be worked out:

Bioinstrumentation—Better bioinstrumentation is necessary with stronger signals and more comfortable and mobile sensors.

Ground-support safety—More effort in industry hygiene to insure the safety of those working in ground support is needed. Noise, toxicity of fuel, etc. remain hazards.

Thermal control—A quicker way to get body temperature is needed since by present means it takes about 12-15 min. for temperature to register. This information is critical and should be fed into the environment system immediately. Suit temperatures must also be watched carefully, since a 10 degree F rise results in twice the water loss.

Life-Support RFP Due Soon

A request for proposals will soon be issued from Langley research center for a three- to six-month life-support system.

A contract is being negotiated and conceptual hardware will be ready by June, 1963, for a 30-60-day integrated life-support system for five men. This prototype will then go to Ames for testing.

Sometime after June a request for proposals will be issued for a one-year system.

The Office of Advanced Research and Technology is working with the Air Force and Manned Spacecraft Center to define requirements before issuing an RFP for extravehicular suits and propulsion units.

An RFP will be issued in about a month for an integrated, psychophysiological monitoring system, including sensors and biomedical computing and recording devices. OART wants a system that could be used in environmental chambers, planes, etc.

Accelerations—G loads may go as high as 20 g's for 60-80 min. if an abort occurs during acceleration phases of *Apollo*. Dr. Connor said the astronauts might not be acceleration-tested very often because it would be so rough on them. Studies are being made on how best to handle this.

Vibrations—Little is known about the effect of direct vibration on the prone man. Since the spine and neck cushions his head when he is sitting or standing, this work cannot be extrapolated.

Radiation—Possible maximum dosages for *Apollo* are causing some concern but are not considered insurmountable. NASA figures that with shielding, dosage would be about 25 RAD basic; 50 RAD with a flare. However, with a giant solar flare (a 1% probability) maximum flux might be 150 RAD. A career limit of 250 RAD will probably be imposed on the astronauts.

Gemini problems—A minor annoyance for *Gemini* astronauts will be the sideway tilt of the two seats. Although not a factor during weightlessness, it may be uncomfortable during long prelaunch periods. Another detail to be worked out is which astronaut gets to fire the "chicken switch." Both seats must eject at the same time to prevent one astronaut from getting blasted by the other's wake.

Better diagnostic methods—Dr. Connor said NASA physicians are still at a loss to figure out how they could have predicted Astronaut Donald K. Slayton's heart murmur.

These problems are being worked out at the temporary laboratories at Houston: *Mercury* environmental, survival, bioinstrumentation, pressure suit, restraint drop-test, inorganic chemistry, and environmental control.

• **Advanced research and technology**—The office of Biotechnology and Human Research under Director Eu-

gene Konecci (M/R Oct. 15, 1962, p. 26) is responsible for work on: a) better understanding of man's capabilities and requirements; b) design requirements for man-machine equipment and subsystems, e.g. life support; c) design engineering requirements for aeronautical, astronautical and ground-support man-machine systems.

A study with the Atomic Energy Commission will start soon to find special effects on man of high magnetic fields. NASA is concerned because if IF lasers can be created by magnetic fields acting on minerals, they may have some effect upon impurities in the body. Brain and other internal damage may result.

Well down the road is applied work on long-term animal weightlessness in orbit. Even flights of more than a year with simulated Mars flight profile while still in Earth orbit are being considered.

Manned Spacecraft Center is doing some life-support and pressure-suit work for OART as an extension of its own work.

• **Space Sciences**—The job of Bioscience programs in this office is basic research in: a) search for extraterrestrial life, b) effect of outer space on earth organisms, and c) support to man in space.

Scientists are trying to prove the existence of other life by synthesizing it in the laboratory, and by direct exploration and sensing. NASA is especially looking for all types of remote life detectors.

Some 50 flight experiments have been selected by NASA for future study of outer space effects on low forms of life.

Primates will be orbited for from three to 14 days and more. NASA is now looking at capsules and reports that it will require one with a 20% oxygen, 80% nitrogen, 14.7 psia environment. The animals will be heavily instrumented. The three-day flight will include a controlled radiation source to study the synergistic effects of radiation and weightlessness.

The office wants to study life-support systems with new concepts, such as the hydrogen fixing plants which may be more effective than algae, etc., in bio-regeneration.

The scientists have found that amino acids, minerals and vitamins can be combined in one material without other food components. One cubic foot of this material would provide a one-month supply for an astronaut at 2000 calories per day. This would include 50% water and save up to 95% in weight and space. If this material looks promising for space use, it may be turned over to OART, which could make it palatable, then to MSC for use. ⌗

BIOASTRONAUTICS WORK AT NASA CENTERS

BIOTECHNOLOGY & HUMAN RESEARCH	Ames	Langley	Flight Research (Edwards)	Houston (MSC)	Marshall	Lewis	JPL
Environmental Physiology	x		x				
Psychophysiology	x		x				
Environmental Control	x	x		x			
Protective Systems	x	x		x		x	
Displays and Controls	x		x				
Systems Analysis	x	x	x		x		
Human Factors	x	x	x		x		
BIOSCIENCES							
Life Detection Devices							
Sterilization of Spacecraft							
Exobiology	x						
Environmental Biology	x						
Behavioral Studies	x						
Collection & Evaluation of Satellite Experiments	x						
AEROSPACE MEDICINE*							
Environmental physiology	x			x			
Accelerations	x			x			
Bioinstrumentation				x			
Life Support space suits				x			
Radiation protection	x			x			
Survival				x			

** Ames and Manned Spaceflight Center work in the same general areas, but Ames performs essentially basic research, while MSC concentrates on Gemini and Apollo.*

NASA LIFE SCIENCES FUNCTIONS

	Basic Science Environment Research	Animal Research	Basic Human Research	Applied Human Research & Technology	Manned Operational Aspects
OSS	√	√			
OART		√	√	√	
OMSF				√	√

GE Develops Satellite Command Unit

UTICA, N. Y.—A highly flexible miniature command unit for satellites is now available that is capable of both real-time and long-delay actuation modes.

Developed here by the Light Military Electronics Department of General Electric, the Miniature Command Unit (MCU) employs a magnetostrictive sonic delay line for limited storage.

The 7-lb. unit requires only four watts during standby operation and nine watts for full operation. Completely transistorized, the system is provided with an integral all-magnesium housing and egg-crate cold-plate chassis.

Developed by two LMED engineers, Richard Tardiff and Thomas Hovey, MCU is an outgrowth of a programmer built by GE for a classified Air Force satellite program. Components employed in the new system are those flight proven in the AF package.

MCU is expected to find applications in scientific and military-type satellite programs, particularly for sensor actuation and recovery operations. It also could find use as a backup system for manned space vehicles.

• **Modular construction** — Sixteen encapsulated modules, physically identical, plus a storage unit, comprise MCU.

Each module starts with a plexiglass circuit board and 32 identical NOR circuits requiring 160 components. The addition of other components and a side-mounted connector at the top individualizes the various modules.

The basic circuit element in each standard 32-element module is a five-component NOR circuit. Multiple input AND or OR gates are formed by adding diodes to the circuit element. A flip flop is formed by combining two elements. Adding a resistor creates a power amplifier.

• **Digital storage**—MCU's memory unit employs a potted drive and a read amplifier plus a sonic delay line. The complete package weighs 15 oz.

Information is stored in the delay line by twisting it in one direction for logical "1" and the reverse direction for logical "0". By employing a 2-msec. delay line, 2000 bits of 1-μsec. pulse length each can be stored.

The drive amplifier receives digital data and supplies a current pulse to an input transducer. The latter consists of a magnetically biased coil that disturbs the magnetic field around a small nickel ribbon. The ribbon is spot-welded perpendicularly to the delay line tangent to the surface of the storage wire.

The magnetostrictive ribbon shortens when the magnetic field is applied, the storage line is twisted, and a proportional twist is propagated to the other end of the wire.

By converting the "received" twist back to an electrical signal through an output transducer, the resulting pulse can then be amplified, reclocked, and reshaped by the read amplifier. The amplifier output is then recirculated to the input transducer, completing the storage loop.

• **System flexibility**—MCU developers claim broad performance flexibility inherent in the unit's basic design. Presently built to supply relay drivers for closures up to 100 relays, the unit may be extended to more than 200 relay closures by adding more bits per word in the data sent to MCU.

Storage capacity can be varied directly by the length of the delay line employed. The weight penalty is about 14 oz./2000 bits of added storage.

By changing the two demodulator modules, MCU can be used with a pulse-radar tracking beacon. With this modification, virtually any link can be used for inputs to MCU.

Storage can be reloaded aloft, and commands can be actuated in real time or delayed for up to several days. Up to 100 commands can be stored.

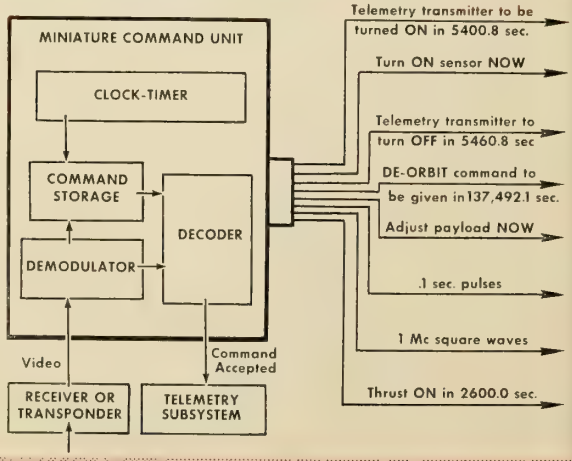
Clock rates can be changed or adjusted in flight. The timer is accurate, according to GE, to 0.1 sec./day. ⌘

Circle No. 225 on Subscriber Service Card

MCU Specifications (Basic Subsystem)

PHYSICAL:	
Dimensions	9½ x 7½ x 4¼ in.
Weight	7.3 pounds
ELECTRICAL:	
Power	—6v d-c ±5% and +6v ±5%; 9 watts (or 4 watts standby)
Storage	1736 bits (56 words @ 31 bpw)
Input bit rate	570 bps max., no min.
Timer	8-kc crystal oscillator
Timing-pulse outputs	1-mc pulse trains to 1 pulse per several days
OPERATING ENVIRONMENTS:	
Pressure	sea level to vacuum
Temperature	—5° to + 65°C
Vibration	random: 0.1g²/cps from 7-2000 cps; sine-wave excitation: 20 g rms, 7-2000 cps (⅛-in. excursion limit)
Shock	50 g, 11 millisec. duration
RELIABILITY (Based on reliability data obtained from components used in earlier operational flight systems.)	0.99 for 168 hrs. 0.96 for 672 hrs. 0.90 for 2160 hrs. 0.68 for 8000 hrs.

Typical MCU Timing, Actuation Outputs



Environmental Chamber

General Technology Corp. offers a standard Model SC-1 environmental space simulation chamber, measuring 4 feet in dia. and 6 ft. long, the SC-1, which offers a free test volume of 3.5x4 ft., is capable of simulating the vacuum and cold black space conditions at altitudes greater than 300 miles. Low loss liquid nitrogen feed-throughs in the chamber walls and door supply liquid nitrogen to the complete cold wall and baffle. The inside cold wall and baffle surfaces provide an emissivity of 0.1. High power and instrumentation feed-throughs are provided, as well as a 6-in. sight port. In addition, four blank penetrations are available on the chamber for added test instrumentation.

Circle No. 226 on Subscriber Service Card

Compact Computer

Designed for aerospace applications, a computer measuring 6-in. square, 7-in. high and weighing less than 17 lbs. has been developed by Univac Div., Sperry Rand Corp. It dissipates only 53 watts of electrical power. In a second, the unit can perform 125,000 additions or subtractions, multiply 30,000 times, divide 15,000 times, or compute 8000 square roots.

An engineering test program subjected the computer to temperature extremes ranging from −65°F to 257°F. The unit withstands shock tests equivalent to dropping an object 40 in. onto a concrete floor, or abruptly stopping an object traveling 250 mph. Studies indicate that the computer will be capable of withstanding the noise level generated by a jet airliner.

Integrated circuits are solid-state circuit semiconductor networks that integrate all of the computer's 18,000 transistors, diodes, capacitors and registors—and their associated interconnections—into tiny semiconductor wafers. One integrated circuit may include up to 18 transistors.

Circle No. 227 on Subscriber Service Card

Low Noise Amplifier

Micro State Electronics Corp. offers a low-noise gallium-antimonide type tunnel diode amplifier.

The model NC-6150-B, which has a 500-mc bandpass at the 1-db point centered at 6150 Mc. The noise figure of the unit is 4.2 db with a nominal 17 db gain. The device can be subjected to any arbitrary loading impedance at the input and output simultaneously, without causing any spurious oscillations either in or out of the frequency band of interest.

Circle No. 228 on Subscriber Service Card

Pressure Transducers

Data Sensors, Inc., has available its Models PB413B (bidirectional) and PB413D (unidirectional), high-accuracy bonded strain-gage differential-pressure transducers. Combined non-linearity and hysteresis for ranges below 50 psid is less than 1% full scale and for the higher ranges ±0.75% of full scale. Low sensitivity to static or vibratory accelerations allows the use of the Model PB413 for rocket-engine test-stand applications.

The units are capable of operating at line pressures up to 2500 psia and temperatures from 0 to 200°F except in ranges of 25 psid or lower which have an operating temperature range of 30 to 150°F.

Circle No. 229 on Subscriber Service Card

Frequency Source

Monitor Products Co., Inc. is marketing its SO-3033B oscillator, a highly stable 100-KC frequency source capable of operating under rugged environmental conditions. Frequency tolerance is ±2 parts in 10^7 over an ambient temperature range of −55°C to 70°C and under high vibration, shock and erratic voltage variations.

Circle No. 230 on Subscriber Service Card



Circle No. 10 on Subscriber Service Card



New Product of the Week:

Moving Target Simulator

A moving video target simulator, Model RP-175-PM, designed for use with modern, precision instrumentation and fire-control radars has been developed by Remanco, Inc.

The unit provides the signals that enable the operator to align, calibrate and test the video and display portions of a radar. It may also be used to drive a suitable RF generator enabling the test and evaluation of many of the functions of a complete radar system.

Video pulses may be manually positioned and programmed in range at constant velocity or from an initial velocity to final velocity at a predetermined acceleration. Provisions are also incorporated for mixing IF noise and for amplitude modulating the pulse to simulate radar scan or target fade effects.

Circle No. 231 on Subscriber Service Card

Alarm & Control System

The reliable interrogation and control of up to 19 supervisory functions at each of 10 remote stations is practical with 936C Alarm and Control System marketed by Lenkurt Electric. The unit is particularly adapted to monitor and control functions at intermediate or terminal locations in multiplex and microwave systems operated by Government agencies. The device is more flexible, since the alarm or the control equipment elements can be purchased separately and used in separate applications.

Circle No. 232 on Subscriber Service Card

Attenuator Line

A line of attenuators, terminations and impedance matching transformers designed to set signal levels, aid in impedance isolation and provide a simple method for improving an impedance match are available from Applied Research Inc. The units are designed for use in applications over the range of d-c to 2500 mcs. The maximum VSWR for the attenuators and the terminations is 1.2/1. The impedance transformers (minimum loss pads) maintain a maximum VSWR of 1.3 at 1000 mcs. The nominal impedance of the attenuators and terminations is 52.5, 75 or 90 ohms. Standard impedance ratios are available in several models of the impedance transformers. Each model is generally accurate to ±½%. The temperature range is −55°C to 100°C and the humidity range is 95%.

Circle No. 233 on Subscriber Service Card

Miniature Amplifier

Statham Instruments, Inc., has developed a miniaturized amplifier for use with piezoelectric accelerometers. The Model SA105-1 was designed for aerospace applications where extended frequency response, high-input impedance, and small size are required. The features of the device are: a biasing circuit which establishes an output level of 2.5 volts d-c with zero input signal, and a limiting circuit that restricts the extreme values of the output signal to zero volts and five volts, eliminating the possibility of interchannel modulation in a telemetry system. Output five volts maximum peak to peak, gain, continuously variable from four to 60, frequency response; three cps to 50,000 cps ±5% normalized to output at 100 cps; one cps to 100,000 cps ±10% normalized to output at 100 cps.

Circle No. 234 on Subscriber Service Card

Potentiometer

A slide-wire potentiometer, qualified for extreme-temperature environments and capable of virtually infinite resolution, is available from New Jersey Div. of Giannini Controls Corp.

Operating temperature range is from −65 to 500°F. Shaft rotation tolerance is +3 to −0° with standard linearity (±0.1%) and +1 to −0° with premium linearity (to ±0.025%). Life with full input voltage is 50,000 degree hours or 100,000 revolutions (whichever occurs first). The ball-bearing servo-mount, multi-turn potentiometer meets MIL-E-5272C for vibration, acceleration (100 g's) and shock (50 g's).

Circle No. 235 on Subscriber Service Card

Kerr Cell Pulser

Developed by Advanced Kinetics, Inc. the Kerr Cell Pulser, type KCP-101, is a fast-risetime, (20 nanosecond) high-voltage, fast-repetition-rate (100 pulses/second) variable-time-base unit, capable of driving a load of 50 μμf or less. The system was designed to drive Kerr cells to be used as switching elements in lasers. As such it can be applied to study population excitation and de-excitation phenomena associated with CS and pulsed laser operation. It also finds application for the production of giant light pulses and other electro-optical modulation experiments. The instrument compactly combines the following components: the high-voltage supply for the output circuitry, continuously variable between four and



10 KV, a low-voltage supply for the pulse trigger circuitry, two parallel pulse circuits, each tailored to a different time-base, and internal repetitive trigger and provisions for external triggering.

Circle No. 236 on Subscriber Service Card

Microwave Antenna

Ainslie Corp. is marketing a line of communication microwave antenna systems in the 6 KMCS band, available in 2-ft. through 4-ft. sizes. Consisting of a sectional horn feed mounted in a



precision spun parabolic reflector, these antennas are for use in common-carrier studio-transmitter links, operational fixed, government, and industrial services.

The feeds are tuned in three broad ranges (over the 5925-7425 MC bandwidth) so that the VSWR remains below 1.1:1 for any specific range. The horn is hermetically sealed, and means are provided for attaching guy wires on models 4 ft. in dia. or larger.

Circle No. 237 on Subscriber Service Card

Sweeping Oscillator

An extended-range model of the Vari-Sweep sweeping oscillator is available from Kay Electric Co. The P-867 plugs into the standard 2-220 megacycle Vari-Sweep and extends its range upwards from 220-428 megacycles. Output voltage of the head is 0.5 volts rms into 70 ohms.

Circle No. 238 on Subscriber Service Card

Tantalum Capacitors

Types CS12 and CS13 solid tantalum capacitors conforming to military specifications MIL-C-26655A have been developed by Fansteel Metallurgical



Corp. These capacitors have ratings ranging from 6 to 35 volts. The miniaturized, temperature-frequency stable capacitors have a solid semiconductor instead of a liquid electrolyte. They are designed for airborne computer, guidance control, telemetering auto-pilot and data-processing electronic systems. They are rated from 0.033 to 330μf and will withstand operating temperatures from −55°C to 125°C.

Circle No. 239 on Subscriber Service Card

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Electronic Comparator

With a switching rate of 200,000 cps, the electronic comparator developed by GPS Instrument Co. is claimed to be the fastest analog comparator available. Comparison time is 5 microseconds.

The Model CS 1050F is a completely solid-state unit which produces an output voltage when the sum of two input voltages equals zero. Sensitivity of switching is within five millivolts for any input voltage up to ±100v. Sensitivity is adjustable to overcome effect of external noise. The output consists of a voltage pulse of 50 microseconds duration and a continuous voltage of 12v.

The unit is useful for comparing known or unknown voltage signals. Its applications include high-speed production testing, comparison of measured variables, and use as a logic element in digital or analog computation.

Circle No. 240 on Subscriber Service Card

Sub-miniature Rate Gyro

American Gyro, a division of Tamar Electronics, Inc. developed a sub-miniature rate gyro, series Model R11, which offers performance standards heretofore unavailable in its size and weight class. Vibration resistance of the R11 is 25 g's up to 2000 cps with a shock resistance of 100 g's along any axis.

The unit incorporates a ball-bearing-supported gimbal, full-temperature-compensated damping and high angular momentum (60,000 to 100,000 gr-cm^2/sec.)

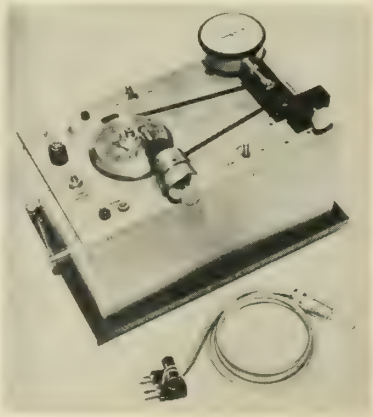
Circle No. 241 on Subscriber Service Card

Torque Tester

American Gyro, a division of Tamar Electronics, Inc., has developed an instrument-bearing torque tester, Model BT-1 to fill an industry need for an ultra-sensitive bearing torque tester capable of testing "break away torque" of precision instrument bearings.

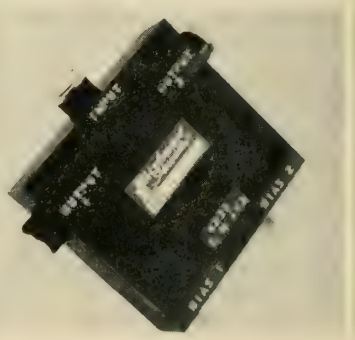
Mechanical torque is measured directly, thereby eliminating the necessity of charts and conversion factors, i.e. volts/degrees or lbs./sq. in. It has a torque capacity of 0 to 20,000 mg. mm., with a sensitivity registration of 50 mg. mm.

Circle No. 242 on Subscriber Service Card



High-Frequency Switch

A high-frequency solid-state switch (5350-5950 Mc) for high-speed antenna switching applications has been announced by Microwave Associates, Inc. The MA-8305-2C2N coaxial type, single-pole, double-throw switch is capable of switching ratios superior to past capabilities. Insertion loss is less than



1 db, and isolation is in excess of 30 db throughout the entire frequency range. Switching speed is on the order of 30 nanoseconds with a maximum drive power of 150 mw.

This switch is useful in a wide variety of applications such as antenna switching, signal modulation, pulse shaping or time sharing techniques, and wherever reliable, high-speed RF switching requirements exist.

Circle No. 243 on Subcsriber Service Card

Compact Decades

A line of stable, compact decades is available from Hopkins Engineering Co. Smaller and lighter than comparable units, they feature high stability. They boast a guaranteed tolerance change of less than ±0.1% over five years and less than 1% change over the entire temperature range from −55°C to 85°C. Designed for computer and instrument applications, the hermetically sealed decades are available in 400v d-c units, 0.01 MFD to 0.1 MFD, 0.1 MFD to 1.0 MFD, and 1.0 MFD to 10.0 MFD.

Circle No. 244 on Subscriber Service Card

Accelerometer

Natural-quartz-crystal transducer elements are a feature of Kistler Co.'s Model 808 piezoelectric accelerometer. The quartz, Kistler says, is virtually unaffected by temperature, time, radiation or mechanical stress. The unit is said to be a versatile instrument for vibration, shock and acceleration measurements over wide ranges of amplitude and frequency. Rigid construction permits measurement of high-level, long- and short-duration shocks without zero shift or signal distortion.

Circle No. 245 on Subscriber Service Card

D-C Power Supply

A 300v at 1000 amp (standard connection) silicon rectifier type d-c power supply for indoor laboratory use has been developed by Perkin Electronics Corp. The device, conservatively rated at 300 kw d-c output at 300 d-c and is capable of supplying 1000 amp continuously over the entire voltage range of 10 to 300v.

Additional d-c connections provide for various output, including 450v at 667 amps, 900v at 333 amps or 150v at 2000 amps.

Circle No. 246 on Subscriber Service Card

PV Power Supply

Developed by Electronic Measurements Co., the Model PV32-15, delivers 0-32 volts at 0-15 amps in constant-voltage or constant-current with auto-crossover. This PV power supply is fully programmable and Mhogrammable (TM) and can be connected to sense IR drops of as much as three volts per load lead for maintaining regulation directly at the load terminals. Regulation in constant voltage is 0.01% or 2 mv line or load. In constant current, line regulation is 0.06% or three ma, load regulation 0.25% or 20 ma, better with external CC conversion.

Circle No. 247 on Subscriber Service Card

Frequency Error Expander

Motorola has developed a unique frequency error expander, which determines the frequency of test signals with resolutions up to one part in ten billion during a 10-second sampling period or one part per billion in a one second count.

The product is used to measure short- and long-term frequency stability, align frequency standard and precision oscillators and provide rapid and accurate comparison of two frequency standards. In operation, the unit checks a one-megacycle test signal against the output of a one megacycle frequency standard, with the deviation between the two expanded up to 1000 times.

Circle No. 248 on Subscriber Service Card

Portable X-Ray Unit

A portable X-ray unit with a range of 35 kv to 140 kv and one to four milliamperes, both continuously variable, has been introduced by Sperry Products Div., Automation Industries, Inc. Typical uses of the device include: inspecting cast, wrought and forged components and weldments; and aircraft structural members.

The 140 X-ray features completely



transistorized circuitry and a gas-filled plastic window tube head with a 40° cone of emission. Varying frequency from 400 to 700 cycles (where 60 is conventional) to gain higher milliamperes. Effective focal spot is 1.5 mm. and minimum radiation output 7.6 roentgens per minute at a distance of 36-in.

Circle No. 249 on Subscriber Service Card

Half-Bridge Resistor

Miniature half-bridge resistor networks offering ±10 ppm/°C temperature coefficient, better than 0.2 ppm/°C tracking and accuracy to 0.5% is available from Vishay Instruments, Inc. The 0.12-in.x0.2-in.x0.025-in. units — with paired etched metal film resistors of either 120, 350, 500 or 1000 ohms values—are rated at 0.5w free-air dissipation at 125°C. Larger units offer resistances up to 100K ohms, 0.01% accuracy, 1-ppm/°C absolute temperature coefficient and TC match of 0.2 ppm/°C. Wattage ratings range to 2 watts.

Circle No. 250 on Subscriber Service Card

Voltage Divider Accessory

Available from Electro Scientific Industries, Inc. the ESI LC 875B lead compensator is a voltage divider accessory for increasing the precision of ratio comparison. When two dividers are connected for comparison, there is usually a slight difference between their respective output voltages at settings of zero and full scale. This difference results from lead and contact resistance differences between the generator and the divider taps. The LC875B is designed to remove these end effects from the calibration by feeding the dividers through low-resistance tapped dividers so that the output taps can be made to agree at the zero and full scale settings. The unit consists of the two auxiliary, low-resistance dividers, with all necessary terminals for connection to the dividers being compared, and to a generator and a null detector.

Circle No. 251 on Subscriber Service Card

Digi-Card

Sanders Associates, Inc. is marketing a digital-to-analog converter Digi-Card circuit module featuring high-input impedance, low-output impedance, and providing a-c output signals directly as well as d-c outputs.

The D-to-A converter card converts four parallel bits of binary information to an analog output accurate to 0.2% of actual value and which, depending on the power supply used, can be either d-c or 50 to 5000 cycles a-c.

Circle No. 252 on Subscriber Service Card

Power Meter

A temperature-compensated power meter developed by FXR Div. of Amphenol-Borg Electronics Corp. measures CW or pulsed RF power to an accuracy of ±1.5% at full scale in six direct-reading ranges from 10 microwatts to three milliwatts.

Designated B831B, this high-precision instrument embodies a special cali-



bration feature that enables the user to read absolute power directly when FXR series 218 thermistor mounts are used.

Circle No. 253 on Subscriber Service Card

Expanded responsibilities as prime contractor and systems integrator for the USAF Standard Space Launch System

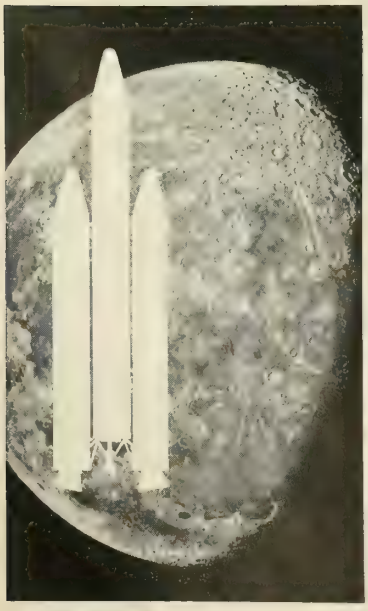
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soviet affairs

By Dr. Albert Parry

A Red view of our rocket-age economy . . .

is given by Yu. Frantsev in *Pravda* for Jan. 2: "America's latest rearmament, the shift to a rocket-nuclear technology, holds a threat of reducing the manpower occupied in war production. Thus, the aircraft industry of the U.S.A. has now 250,000 workers less than it had in 1957-61. . . . The shift of the aircraft industry to the now predominant manufacture of rocket weapons leads to a certain curtailment of demand for steel, aluminum, lathes and forge-press equipment. The first signs of an analogous process begin to appear also in the shipbuilding industry. . . . The circle of capitalists profiting from the arms race tends to narrow instead of widening. This causes a rising mood of opposition to the policy of militarism, not alone among workers but, to a certain extent, also among the bourgeoisie. It used to be that the monopolies shared a little of their fat profits with some strata of the working class and certain groups of the petty and middle bourgeoisie. But that was at the very start of the creation of the huge, brand-new rocket-nucelar industry. Basically this has already been created." This accomplishment, Comrade Frantsev claims, is causing growing dissatisfaction among Americans who have either failed to profit from our military expenditures or whose share of such "crumbs" has recently been cut down.

The economic lopsidedness of the Russian rocket effort . . .

is, on the other hand, recognized as an issue by the well-known Soviet writer Viktor Nekrasov in a recent issue of the Moscow *Novy Mir*. Describing his travels and conversations in Italy, Nekrasov says that certain Italian Communists complained to him that although they were happy with the triumphs of the Soviet cosmonauts, many other Italians were not. Nekrasov quotes Italian Communists: "The average Italian, particularly the person who has visited the Soviet Union—and there are increasingly many who have—inevitably asks the question: 'But why they, the Soviets, having sent their *Sputniks* around the Moon, still cannot get rid of those lines in front of their stores?' And these are not idle questions. They are essential questions." Nekrasov was told by his Italian Communist friends that both kinds of Communists, Italian and Russian, must answer these questions. The Italians say: "You Russian Communists must reply first. But you frequently procrastinate with such answers, and then sidestep the issue. In the meantime the answer—right or wrong, that is another matter—is given by the enemy, and it is often listened to. But you Russian Communists don't realize this."

Will the Soviet *Mars-1* report life . . .

on that planet when the rocket finally comes close enough to Mars to send photo-signals from its vicinity? Some Soviet scientists express hope and even conviction that life of one kind or another will indeed be discovered on Mars by the Soviet rocket. Typical of such statements is V. Davydov's assertion in a recent issue of the Moscow *Aviatsia i Kosmonavtika:* "Even though organisms existing on Earth cannot live under the conditions prevailing on Mars, that planet does have main conditions which would allow albumen organisms to exist there. Water is a milieu for living processes. Mars does have water. The mean day-and-night temperature of that planet does not preclude life. Mars also has an atmosphere. Is oxygen necessary? We know organisms that do not need oxygen." Davydov is identified by the Soviet magazine as "the learned secretary" of the State Astronomical Institute.

The recent death of Prof. Alexander Topchiev

is a loss to Soviet rocketry. A top research chemist, he was credited with a major role in the development of Russia's rocket fuels, and apparently contributed to their considerable thrust.

The Industry Week

Raytheon Splits Divisions

Raytheon Co. has divided its two major government-oriented divisions to form four new operating units. The former Equipment Div. and Missile and Space Div. are now supplanted by: *Space and Information Systems Div.,* consisting of operations at Sudbury and Waltham, Mass., and Santa Barbara, Calif., as well as the newly acquired Autometric Operation on Long Island, N.Y.; *Missile Systems Div.,* including operations at Lowell, Andover and Bedford, Mass.; *Equipment Div.,* including the Surface Radar and Navigation Operation, the Communication and Data-Processing Operation, the Electronic Services Operation and the Raytheon Canada (Kitchner, Ont.) Operation; and *Submarine Signal Div.,* consisting of the former Submarine Signal Operation, which used to be part of the old Equipment Div.

Each of the new divisions will have its own marketing, engineering, manufacturing and service functions.

RCA Honored for Tiros

The American Meteorological Society has given an award to Radio Corp. of America honoring the firm's "outstanding services to meteorology" in development, testing and production of *Tiros* meteorological satellites for the National Aeronautics and Space Administration.

Barton Kreuzer, VP and general manager of the Astro Electronics Div., RCA Defense Electronic Products, accepted the award for RCA.

The firm's work on the Television Infrared Observation Satellite was performed under the technical direction of NASA's Goddard Spaceflight Center, Greenbelt, Md.

AF Consolidates Inspection

The Air Force's world-wide inspection and safety functions, headquartered at Norton AFB, San Bernadino, Calif., have been consolidated and reorganized, in keeping with a continuing AF program standardizing organization structures at the Pentagon level.

The Office of Deputy Inspector General for Inspection and the Office of Deputy Inspector General for Safety have joined to form the Office of Deputy, The Inspector General. Maj. Gen. C. W. Schott headed the new unit for the brief period before his retirement Jan. 10, and was replaced by Maj. Gen. Perry Griffith. The changes were announced retroactively by the AF only recently.

Under the reorganization, the Directorates of Systems Inspection, Support Systems Inspection and Procurement Inspection became a single Directorate of Inspection, which now contains the Aeronautical Systems, Space and Electronic Systems, Support Services and Procurement Divs.—all at Norton AFB.

The safety arm now is divided into two parts: the Directorate of Aerospace Safety, including Flight, Ground, and Missile Safety Divs. at Norton; and the Directorate of Nuclear Safety, encompassing the Weapon Systems, Reactor and Advance Systems, and Engineering and Analysis Divs., all at Kirtland AFB, Albuquerque, N.M.

More Titan Savings Sought

Martin Co. officials will try to match in 1963 the $40 million that the firm and its suppliers report they saved last year in *Titan* costs.

Martin General Manager George Smith, in a keynote speech during the firm's second cost reduction symposium, told a Denver audience that Martin Marietta Corp.'s aerospace functions chopped $40,853,275 from the *Titan* bill in 1962. This, he said, represents about 10% of all *Titan* contract money administered by Martin-Denver last year.

In making the savings, Smith said, the company fulfilled a promise it made to the Air Force at the company's first cost reduction symposium a year ago.

Industry Facilities

Control Data Corp.'s Data Centers Div. this week moves into a new Control Data Building near Washington, D.C., in the North Bethesda, Md., Office Center, being developed by Adams, Eisinger, Kilbane and Amatucci. The division will be located on the 22,000-sq.-ft. first floor of the four-story facility, and all other Washington-area Control Data operations will occupy the other floors as they are completed later in the spring. The new quarters will allow planned enlargement of the firm's resident engineering staff. . . . *The Deutsch Co. has broken ground for a new $400,000 corporate headquarters facility on 2½ acres at the Los Angeles International Airport. Corporate staff, corporate R&D, management and production activities of the firm will occupy the new facility in June, as will the Los Angeles sales office of Deutsch Electronic Components Div., Banning, Calif., connector manufacturer. Other Deutsch functions are at South Figueroa, Calif., and Toronto, Canada, as well as in France and England.* . . . G. L. Collins Corp., developer-manufacturer of precision linear-position transducers and electronic components for missile/space applications, has opened a new $1-million R&D facility in North Long Beach, Calif. The facility, designed by Millie & Severson, is three times the size of the firm's former R&D quarters, which now will be used by the Collins Sales Div.

Patent Peace Pact

Sperry Rand Corp. and Technitrol, Inc., have agreed to a settlement out of court in a long-waged dispute over alleged violations by Sperry of Technitrol patents covering magnetic memory devices.

C. E. McTiernan, VP for patenting and licensing services in Sperry's Remington Rand Div., announced the settlement, saying that it was "to the mutual satisfaction of both parties."

Military Systems Issue

On March 25 Missiles and Rockets will devote its entire Military Systems Issue to explaining the missile/space procurement and engineering philosophy of the Department of Defense. This issue will include in-depth articles about how and why missile/space decisions are made at the DOD level.

Three sections in the Military Systems Issue:

DOD Policies—McNamara's Pentagon Reorganization / DOD Budget and Programs / Procurement / Research and Engineering.

DOD Operations—How a Weapons System is Approved / How Industry Can Operate at the DOD Level / How Other Agencies Affect DOD Decisions / How Well is the Pentagon Reorganization Working?

The Decision Makers; the role and influence of eleven key DOD offices and agencies in missile/space decisions—Secretary McNamara's Office / Comptroller Office / Research and Engineering Office / Procurement Office / Joint Chiefs of Staff / Office of the Secretary of the Air Force / Office of the Secretary of the Army / Office of the Secretary of the Navy / Defense Supply Agency / Defense Communications Agency / Institute of Defense Analysis.

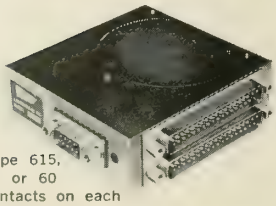
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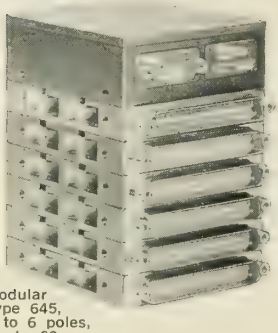
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contracts and procurements

AWARDS

AIR FORCE

$105,535,238—**Boeing Co.,** Seattle, for *Minuteman* missiles, spare parts, and ground equipment (3 supplemental contracts). Work to be performed in Seattle and Clearfield, Utah.

$25,308,048—**Boeing Co.,** Seattle, for fixed assembly and checkout of equipment of *Minuteman* sites at Malmstrom AFB, Mont.; and for engineering and development for improved *Minuteman* missiles at Seattle (2 supplemental contracts).

$7,798,533—**Boeing Co.,** Seattle, for work on *Dyna-Soar* program.

$4,500,000—**Avco Corp.,** New York City, for work on *Minuteman* re-entry vehicles (supplemental contract). Work to be done in Wilmington, Mass.

$4,449,730—**Douglas Aircraft Co., Inc.,** Santa Monica, for B-47 bomber maintenance at Tulsa and work on *Genie* rocket motors at Sacramento and Santa Monica (2 contracts).

$2,000,000—**Sylvania Electric Products, Inc.,** New York City, for continued research and development on *Minuteman* missile base security subsystems. Work to be done in Mountain View, Calif.

$1,490,500—**Columbia University,** New York City, for research on radar system design, defense problems and related matters.

$1,000,000—**Antenna Systems, Inc.,** Manchester, N.H., for the design, fabrication, installation, and test of 85-ft. and 30-ft. automatic tracking and telemetry antennas for use in missile and satellite programs on the Atlantic Missile Range.

ARMY

$9,831,854—**Raytheon Co.,** Andover, Mass., for developing radar for the *Hawk* missile system's tracking targets.

$7,000,000—**General Telephone and Electronics Corp.,** Waltham, Mass., for further development of high-precision, weapons-locating equipment.

$2,201,846—**Martin Co.,** Orlando, Fla., for maintenance, consultation and training services at nine Missile Master electronic air defense sites.

$1,909,904—**Aeronca Manufacturing Corp.,** Middletown, Ohio, for warhead parts for the *Nike-Zeus* antimissile missile.

$1,370,270—**Bendix Corp.'s Eclipse Pioneer Div.,** Teterboro, N.J., for developing radar for the *Hawk* missile system's tracking targets.

$1,100,000—**Raytheon Co.'s Missile and Space Div.,** Bedford, Mass., for work on a classified research and development program.

NAVY

$4,756,696—**General Motors Corp.'s AC Spark Plug Div.,** Milwaukee, Wis., for gyros for the *Polaris* missile program.

$4,154,232—**Franklin Institute,** Philadelphia, for operation of the Naval Analysis Center and for research on naval equipment.

$1,204,066—**Hughes Aircraft Co.,** Culver City, Calif., for guidance systems for *Polaris* missiles. Work to be done in El Segundo, Calif.

$292,000—**Republic Aviation Corp.,** Farmingdale, N.Y., for acceleration of the Office of Naval Research's space engine research development.

NASA

$3,610,632—**Bell Aerospace Corp.,** Buffalo, N.Y., for building of two manned lunar landing research vehicles.

$2,900,000—**Documentation, Inc.,** Bethesda, Md., for second-year operation of the scientific and Technical Information Facility which collects, processes, and distributes technical information for the nation's aerospace community.

$1,900,000—**Radiation, Inc.,** Melbourne, Fla., for production of one prototype and eight additional digital command encoders for the worldwide manned spaceflight tracking network.

$320,000—**American Machine and Foundry's AMF Atomics Div.,** Greenwich, Conn., for design, building and installation of remote handling equipment for nuclear research in the Plum Brook Reactor hot laboratory.

$140,000—**Giannini Controls Corp.'s Systems Div.,** Duarte, Calif., for research and development on application of energetic particle techniques in air density measurements at upper atmospheric limits.

U.S. ARMS CONTROL AND DISARMAMENT AGENCY

$215,000—**Aerospace Corp.,** El Segundo, Calif., for a study of ballistic missile and military space developments as they relate to arms control and disarmament measures.

INDUSTRY

$300,000—**National Water Lift Co.,** Kalamazoo, Mich., from the **Boeing Co.,** for provision of hydraulic elevon actuators for the *X-20 Dyna-Soar* spacecraft program.

$172,000—**Talley Industries, Inc.,** Mesa, Ariz., from the **Boeing Co.,** for design, development and manufacture of explosive fasteners for the *X-20 Dyna-Soar* spacecraft program.

$123,000—**Thiokol Chemical Corp.,** Bristol, Pa., from the **Boeing Co.,** for provision of arm-disarm devices for portions of the *X-20 Dyna-Soar* spacecraft program.

$96,000—**Sun Electric Corp.,** Chicago, from the **Boeing Co.,** for provision of the hydraulic power supply for the *X-20A Dyna-Soar* spacecraft program.

Hughes Aircraft Co., Culver City, Calif., from **Collins Radio Co.,** for travelling-wave tube amplifiers to be used aboard the *Apollo* manned lunar spacecraft (undisclosed amount).

Goodyear Aircraft Corp., Akron, Ohio, from **Jet Propulsion Laboratory,** for design and construction of an expandable antenna for use on planetary spacecraft (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Contracting Opportunities Aerospace Procurement Div.
Subsystems Procurement Branch
Norton AFB, Calif.

Component in support of the SM65 *(Atlas)* missile guidance system. 1420 ND 000185RAC proof mass and matched accelerometer strings, P/N 2-00054-252—12 each. Items being procured on this RFP were developed and produced by American Bosch Arma Corp., Arma Div., Garden City, N.Y. Drawings, engineering data, specs and copies of RFP not available through Air Force channels for distribution. Negotiation for these supplies are being conducted with American Bosch Arma Corp., Arma Div. Inquiries relating to subcontracting opportunities should be made directly to the above contractor. Signed Leo A. Weaver, Acting Deputy Chief, Aerospace Procurement Div., Directorate of Procurement and Production. RFP 04-607-63-398.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

A prototype propellant-loading control system in accordance with procurement spec drawing 75M-05009 entitled "Design Criteria for a Digital Propellant Loading Control System" for the development of propellant loading control systems for the *C-5 (Advanced Saturn)* vehicle. RFP Q-28-3. RFP due date 2-18-63.

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when and where

FEBRUARY

American Society for Testing and Materials Committee Week, Queen Elizabeth Hotel, Montreal, Canada, Feb. 4-8.

Engineering for Major Scientific Research Programs Symposium, Georgia Institute of Technology, Atlanta, Feb. 5-6.

Society of the Plastics Industry, Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Feb. 5-7.

Electronic Sales-Marketing Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques, UNESCO Bldg., Paris, Feb. 11-15.

Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory, Engineers Club, Dayton, Ohio, Feb. 12-13.

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Colo., Feb. 18-19.

Conference on Crew Escape Techniques for Aerospace Vehicles, sponsored by Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Feb. 19-20. (Secret)

American Society for Quality Control Annual Reliability Symposium, Statler-Hilton Hotel, Los Angeles, Feb. 20.

1963 International Solid State Circuits Conference, sponsored by IRE, AIEE, and University of Pennsylvania, Philadelphia, Feb. 20-22.

American Society for Quality Control, Quality Control Conference, Flamingo Hotel, Las Vegas, Feb. 21-22.

Society for Nondestructive Testing and Southwest Research Institute Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, Granada Hotel, San Antonio, Tex., Feb. 26-28.

Society of Plastics Engineers, Annual Technical Conference, Biltmore and Statler-Hilton Hotels, Los Angeles, Feb. 26-Mar. 1.

American Physical Society Meeting, Rice Institute, Houston, Feb. 28-Mar. 2.

MARCH

American Society for Quality Control Annual Seminar, Engineers Club, Dayton, Ohio, Mar. 2.

American Society of Mechanical Engineers, Aviation and Space, Hydraulic and Gas Turbine Conference and Products Show, Statler-Hilton Hotel, Los Angeles, Mar. 3-7.

1963 Microminiaturization Congress, Sheraton Hotel, Philadelphia, Mar. 5-7.

Institute of the Aerospace Sciences National Propulsion Meeting, Pick-Carter Hotel, Cleveland, Mar. 7-8.

American Society for Quality Control Annual Quality Control Forum, King Edward Sheraton Hotel, Toronto, Canada, Mar. 9.

American Institute of Chemical Engineers National Meeting, Roosevelt Hotel, New Orleans, La., Mar. 10-14.

American Rocket Society, Electric Propulsion Conference, Colorado Springs, Colo., Mar. 11-13.

National Assn. of Corrosion Engineers, Annual Conference and International Congress on Metallic Corrosion and Corrosion Show, Americana Hotel, New York City, Mar. 11-15.

Instrument Society of America, National Conference on Instrumentation for the Iron and Steel Industry, Pick-Roosevelt Hotel, Pittsburgh, Mar. 13-14.

Society of Vacuum Coaters, Annual Technical Symposium on Vacuum Metallizing, Park-Sheraton Hotel, New York City, Mar. 14-15.

American Society for Quality Control, Annual Quality Control Clinic, Milwaukee Inn, Milwaukee, Wis., Mar. 15.

American Rocket Society and Institute of the Aerospace Sciences, Space Flight Testing Conference, Cocoa Beach, Fla., Mar. 18-20.

American Society for Metals, Western Metal Exposition and Congress, Pan Pacific Auditorium, Los Angeles, Mar. 18-22.

Society for Nondestructive Testing, Spring National Convention, Ambassador Hotel, Los Angeles, Mar. 18-22.

Optical Society of America, Spring Meeting, Robert Meyer Hotel, Jacksonville, Fla., Mar. 25-27.

American Physical Society Meeting, St. Louis, Mo., Mar. 25-28.

Institute of Electrical and Electronics Engineering International Convention, New York Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 25-28.

American Society for Quality Control, Annual Quality Control Conference, University of Rochester, Rochester, N.Y., Mar. 26.

American Power Conference, Sherman house, Chicago, Ill., Mar. 26-28.

American Chemical Society, Spring Meeting, Los Angeles, Calif., Mar. 31-Apr. 5.

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The Centralization of Defense

AS THE CENTRALIZATION of military decision-making in the hands of the Dept. of Defense has become more apparent, the individual services have stepped up their criticisms of the move. Now, in open reply, Deputy Secretary Roswell Gilpatric has spelled out carefully the DOD philosophy in this area.

His remarks, before the National Association of Manufacturers, deserve careful consideration by the industry because they herald significant changes in the traditional military procurement pattern.

Mr. Gilpatric points out a number of innovations in recent years which have made the new approach necessary:

- Under Secretary McNamara's program-packaging, the principal roles of the military now cut across service department lines. The strategic package, for example, combines both Navy and Air Force missiles.
- All combat operations now are in commands functioning directly under the Joint Chiefs of Staff, who report to the Secretary of Defense, not to the service secretaries.
- Machinery for gathering, analyzing and presenting the data necessary for decision-making has, due largely to the extensive use of automatic data computing by the military, advanced to a point where centralized decision-making is both efficient and attractive.

These changes mean, according to Mr. Gilpatric, that only two basic choices are open to the Secretary of Defense in his approach to the job.

One is to conceive of his function as primarily policy-making, with the use of budget ceilings to back up his determinations. This would mean most of the decision-making would be handled by the Joint Chiefs of Staff. Areas such as research and development and procurement would be delegated to the service secretaries and their staffs.

This approach has been ruled out by Secretary McNamara.

The other concept, which he has adopted, is for the Defense Secretary to retain in his own hands the basic decision-making power in all major areas. This leaves to the military and civilian components of the services and commands the responsibility for executing the Secretary's decisions and performing the operations called for by them.

This means the powers of the Joint Chiefs, the services and service secretaries in regard to policy, research and development, and procurement definitely have been downgraded. They become little more than operational arms under this concept. Mr. Gilpatric makes that clear.

"It no longer makes sense, as it did ten years ago, to leave to the service secretaries some of the major decision-making except insofar as a service secretary acts as executive agent for two or more services," he states.

This is the first time this fundamental change in the role of the services and service secretaries, relegating them to relatively minor importance, has been so clearly delineated.

Its implications are massive—for the nation, the industry and for the military services. Centralization of military power in the hands of a few men is always something to be watched carefully. Its undertones of unification must be studied. The ability of a small group to cope with the thousands of necessary decisions must be kept under scrutiny.

Nothing less than the military efficiency and morale of the United States is at stake.

One question which has been raised is this: Will successors to Mr. McNamara and Mr. Gilpatric, who perhaps will lack their tireless attention to detail, be able to handle such a formidable task?

Mr. Gilpatric thinks they will. He notes that in this year's budget sessions more than 700 issues were dealt with over a period of several months by Mr. McNamara and himself.

These range from decisions on *Nike-Zeus* production and *Skybolt* cancellation to the question of whether the new hospital addition at Andrews Air Force Base should have 150 or 175 beds.

"It was no unbearable chore for Mr. McNamara and myself to make these decisions, within the time alloted, personally and without delegating the task to others," Mr. Gilpatric states.

THERE ARE SEVERAL THINGS in this which disturb us. Mr. Gilpatric says the data necessary to reach conclusions on these big and small matters can now be compiled and presented in succinct and readily assimilable form.

But we wonder about the efficiency of a system which requires the Secretary of Defense and his Deputy Secretary to make a decision on 25 beds in a base hospital. We must ask whether their time should be occupied with this when they also are considering such fundamental and massive decisions as *Nike-Zeus* and *Skybolt*.

We must ask a much more fundamental question than the one of whether the successors to Mr. McNamara and Mr. Gilpatric can handle the job. When the centralization policy is fully implemented, when many thousands of decisions now made at lower levels are passed up, can even Mr. McNamara and Mr. Gilpatric handle the job?

The Soviet government five years ago found the demands of overwhelming centralization so great that it decentralized to a vast extent. Perhaps our data gathering and compiling machinery is greatly superior to that of the Soviet Union. Even so, we may be heading either toward a massive logjam in our decision-making machinery or toward decisions which lack depth of fundamental knowledge.

Generally, we approve the moves toward more centralized power and control for DOD. But a careful watch must be kept to assure that it is not overdone by its enthusiasts. Perhaps Mr. Gilpatric was overstating his case to make a point. We certainly hope so.

William J. Coughlin

Flight test engineers and analysts

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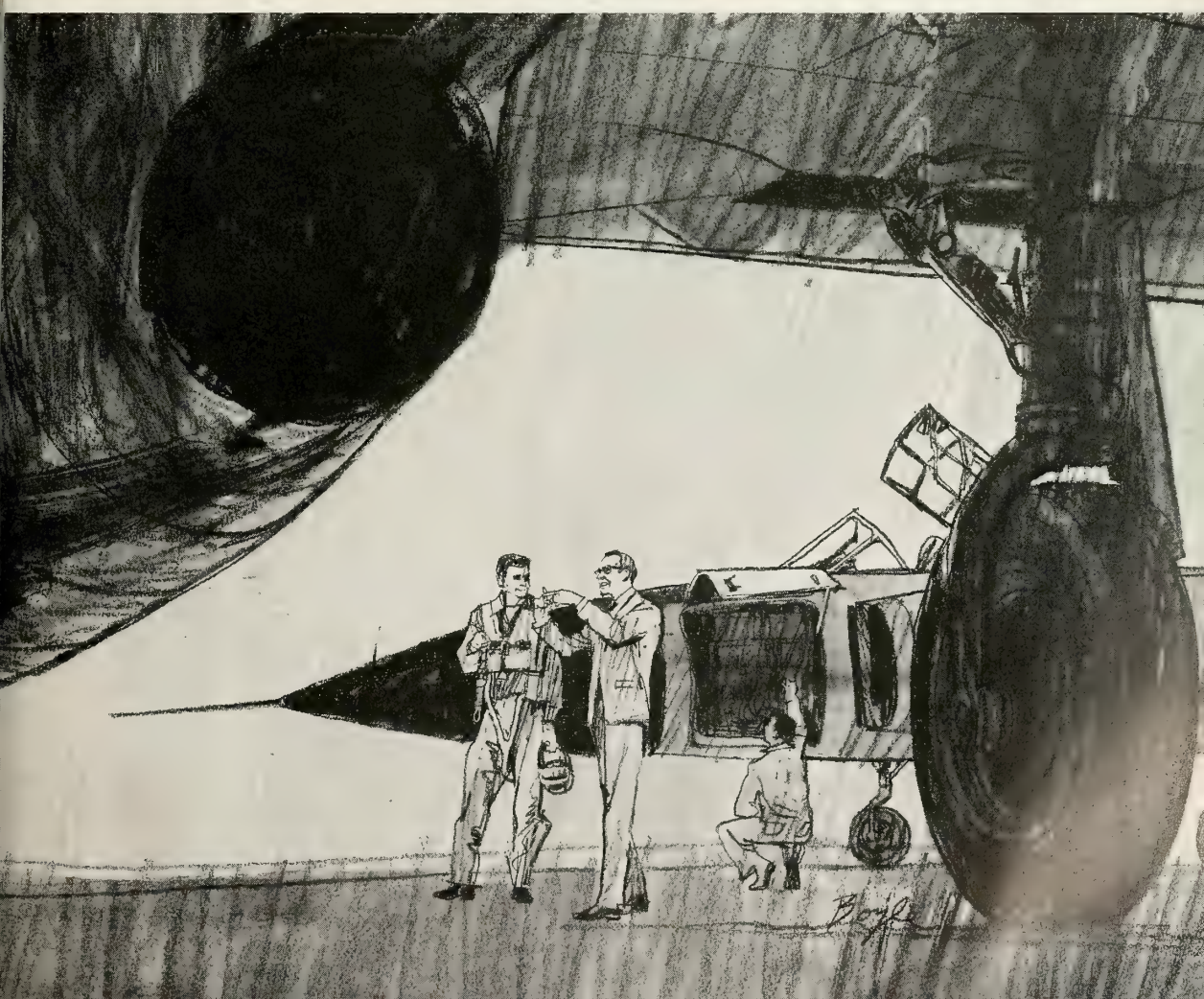
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FEBRUARY 11, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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TO MEN WHO CAN LOOK DEEP INTO TOMORROW

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Top echelon positions are open to men with vision at Bell Aerosystems Co. This growing organization today needs *more* senior scientists and engineers who can perceive where technology should go to meet tomorrow's aerospace requirements—and lead the way to advances beyond the existing state-of-the-art.

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SOFTWARE

The hardware for space travel is coming along nicely. The software for space travel is people, about whom a great many issues are clear and some are not. Clear: a man can survive a few hours out there. (Nikolayev, 96½ hours, no known after-effects.) To be determined: can a man survive in space for weeks, or months? (On a round-trip to the moon, for example. Or in an orbiting space station.)

The most versatile and valuable component of any space system is man. His welfare out there is going to depend (in part) on the environment inside his vehicle. And the composition and pressure of that environment will depend on engineering requirements: weight, power, reliability. Suppose a pure oxygen, low-pressure environment were selected. How would our Astronauts function during a two-week mission?

NASA needs to know. They assigned us to find out. We're doing it right now.

The theory is simple enough. The procedure is not. It starts with our Environmental Test Chamber, a steel cylinder 30′ x 18′ in which we can produce various combinations of temperature, pressure, humidity, vibration and atmospheric composition. Inside, in groups of 6, go healthy young men to breathe pure oxygen for two weeks. For each group the pressure is changed. Pure oxygen at 5 psi for the first group, 7.4 psi for the second and 3.8 psi for the third. A fourth group, breathing air at 14.7 psi, serves as control.



Outside the chamber are specialists in aerospace medicine, physiology, psychology, microbiology, biochemistry and environmental testing. During each two-week period this team performs 683 specific tests on each man (mental, sensory, motor, pulmonary, hematological and microbiological.) The group is assisted by instruments (polygraphs, oscillographs and the like) that automatically monitor and record each subject's reactions.

Probably the most significant oxygen pressure in the test program is 5 psi. That's the environment currently used for Project Mercury. It is also under consideration for Project Gemini, a planned two-week orbit for two Astronauts. Long before they go up, the "unknowns" of living in an oxygen environment will have become knowns. And the hazards thereof, if any, will have been pinned down, studied and eliminated.

This research, supported by NASA, is being carried on in our Space Environment and Life Sciences Laboratory, to determine the effects of space travel upon the software as well as the hardware.

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Combining the high resolution of optics with the sensitivity and automatic response of electronics, optical tracking is a powerful means for accurately pointing instruments and weapons at high-speed vehicles traveling inside or outside the earth's atmosphere. Barnes Engineering Company, a leader in the technology of optical tracking, now offers 'off-the-shelf' capability in tracking sensors and systems.

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Write for Series 21 bulletins.

*Patent Numbers: 2,961,545; 3,007,053; 3,061,730; others applied for.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 6 February 11, 1963

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THE COVER

Apollo launch escape motor was tested successfully for fifth time by Lockheed Propulsion at Potrero, Calif., Jan. 31. Four nozzles split flame of solid rocket. In operation, motor would be mounted tail down on escape tower.

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FOUR MAJOR NEW PROGRAMS ASSIGNED

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Qualified Scientists and Engineers Are Needed Now!

1 **AEROSPACE COMMUNICATIONS:** Development of an advanced intercontinental communications capability has just been assigned to MITRE by the Air Force. Conceived by MITRE's Technical Staff, the new program will involve space technology as well as accompanying ground environment. Engineers and scientists are needed now to help direct this major program. In addition to design, work will include test and system acquisition. Wanted are people with broad backgrounds in space electronics and technical management.

2 **NUCLEAR DETECTION:** MITRE has recently been assigned the task of providing the Air Force with system design of NUDETS — the 477 L Nuclear Detection and Reporting System. The system detects, locates and reports nuclear detonations that occur within specified geographical areas. Needed are qualified physicists and engineers with experience in nuclear, electronic and optical fields.

3 **POST ATTACK Command and Control (PACCS):** The Air Force has recently assigned MITRE the task of being a system engineer for the PACCS Program, a Post Attack Command and Control System. This system will enable the Commander-in-Chief, Strategic Air Command, to improve control of his forces in the event that a nuclear attack destroys or seriously degrades his normal facilities. To accomplish the role of system engineer and to provide technical support, computer people are now needed to help design the system; to write sub-system specifications; and to carry the system through advanced development stages.

4 **U. S. STRIKE COMMAND:** MITRE scientists are now completing a functional analysis of command operations, working directly with the Army and Air Force staff officers. More men are needed to write specifications for computer programs and to conduct laboratory design verification studies of logistics, intelligence, targeting, communications and other functions involved in joint task force operations. Needed are systems-oriented designers with a good understanding of military operations.

Minimum requirements, B.S., or M.S., or Ph.D. in these disciplines: electronics, physics, and mathematics. MITRE is located in pleasant, suburban Boston. Rewards are competitive. Write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, P.O. Box 208G, Bedford, Massachusetts.

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—letters—

Defense Centralization

To the Editor:

Speaking as an individual, aside from any views my employer might have, I applaud your editorial on centralization of power in DOD ("The Centralization of Defense," M/R, Feb. 4). The original idea of unification stemmed, I think, from the Pearl Harbor fiasco, where General Marshall was out riding a horse or something and someone else didn't believe the warning radar and the Navy ships were there like sitting ducks. The services weren't coordinated. Then, there was the economy kick—one uniform, one brand of beans for soldier, sailor or marine. So, we had unification, but the basic missions remain different and the traditions of the individual services remain important.

I haven't liked some of your editorials, such as the one downgrading the astronaut heroes, the first real heroes we have had in American history in some time, perhaps since World War II and Lindbergh. However, a decision by a high DOD officer on how many beds to be put in a base hospital is rediculous and indicates faulty logic at the top. It makes me shudder to think what has happened to our so-called management team, and why so many pipsqueaks are anxious to assume awesome responsibilities without real qualification or ability. To my mind, a strengthening of the role of each service secretary and the JCS, and the cutting of red tape are paramount. The Secretary of Defense should be a coordinator and squabble settler, not an autocratic ruler.

Admiral Rickover had the guts to speak out. To put a clamp on other military men, suppressing their expression of views publicly, is dictatorship pure and simple. We still have Congress and freedom of the press, but sometimes I wonder where we are heading in this thought-control business—telling the people what someone in government thinks they ought to know.

Willard R. Moody
Riverdale, Md.

Apollo Building Designers

To the Editor:

We wish to draw your attention to the fact that the picture entitled "Apollo Launch Structures Designed" on p. 39 of M/R, Jan. 14, was published without proper credit. We would appreciate your giving credit to Urbahn-Roberts-Seelye-Moran (URSAM) of New York, who are designing the *C-5* Vertical Assembly Building depicted. This firm is a joint venture of the Office of Max O. Urbahn, Architects, Roberts & Shaefer, Inc., Seelye Stevenson Value & Knecht, Inc., and Moran, Proctor, Mueser & Rutledge, all of New York.

William D. Alexander
Project Manager
URSAM
New York, N.Y.

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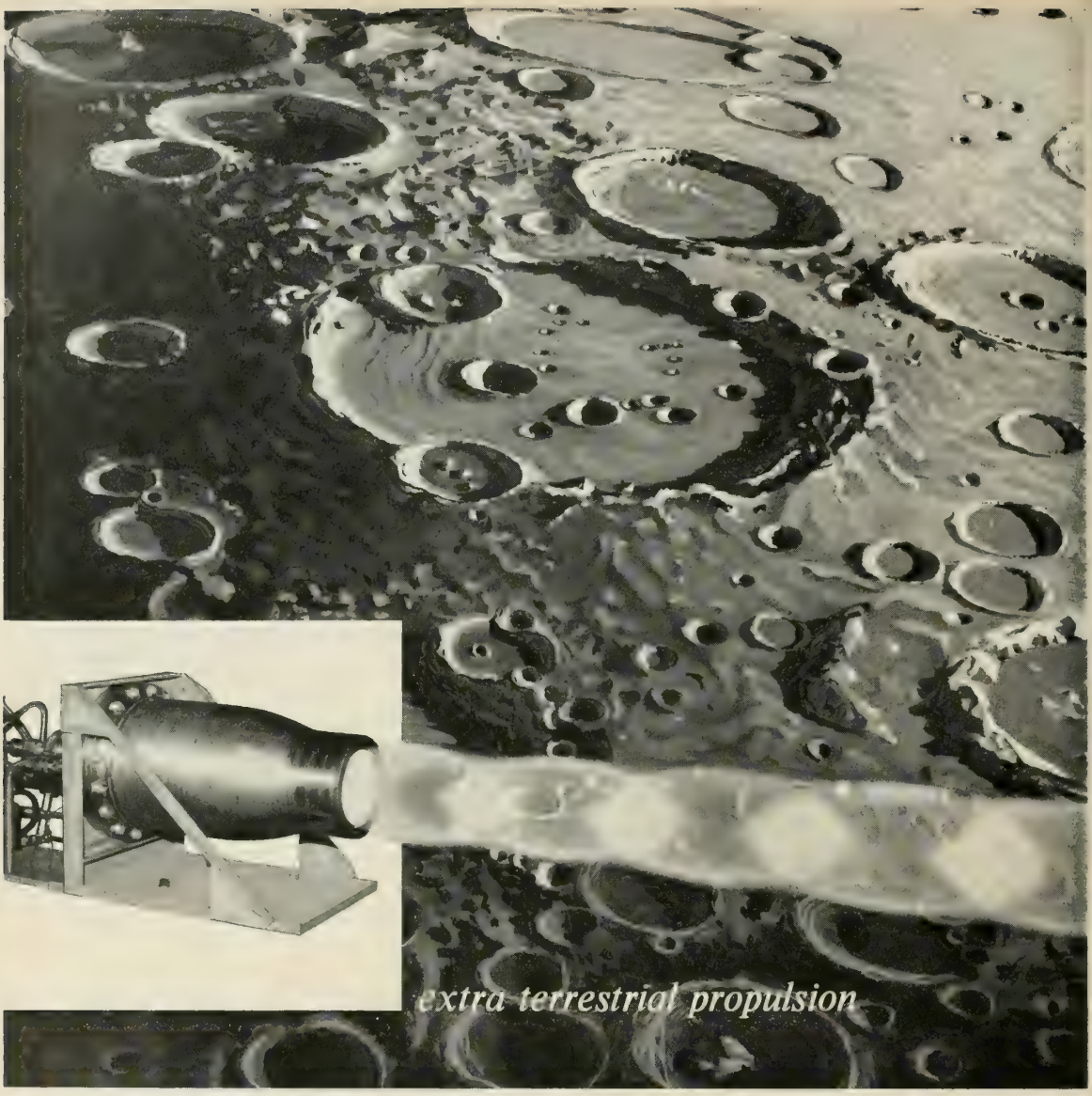
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517

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The Countdown

WASHINGTON

NASA Puts Incentive in CPFF

NASA is developing new contracting procedures to put an incentive feature into cost-plus-fixed fee contracts. Under this, the fee will be set somewhat lower than standard—5% rather than 6.3%, for example—and then raised up to a limit of 10 or 15% after evaluation by an annual review board.

Minuteman Motors Shipped from Plant 78

Initial shipment of first-stage *Minuteman* motors produced by Thiokol-operated Air Force Plant 78 has been made to the assembly and checkout facility, Plant 77, at Hill AFB, Utah. First motors produced by Plant 78, near Brigham City, Utah, were used in qualification tests of the production facility.

White House Contract Pressure Is Increasing

It's no secret in Washington that the White House is playing an increasingly active role in selection of NASA and Dept. of Defense contractors. Officials evaluating one major program got four phone calls from the White House in one week, urging selection of a particular firm. Insiders say one advantage of the new two-stage contracts will be that the list of firms submitting acceptable capability bids can be screened by the White House before award of the competitive design contracts. In this way, all finalists will be politically acceptable.

ABRES Program Gets Under Way at Cape

Advanced Ballistic Re-Entry Systems (ABRES) program will get started late this month at Cape Canaveral to test new shapes, designs and theories in re-entry vehicles. Standard *Atlas* boosters launched by Air Force crews will be used for the flights into the Ascension Island area.

Slippage Admitted in MA-9 Shot

NASA officials admit that some slippage in the *MA-9 Mercury* shot set for April 2 at Cape Canaveral is certain. But they say extent of the delay won't be known until further tests are run. Wiring problems in the control system of the *Atlas* booster are blamed.

March 1 Set as LEM Contract Target

NASA is shooting for a March 1 target date for completion of negotiations covering the remaining phases of the Lunar Excursion Module (LEM) development. Signing of a final definitized contract then will take place. Grumman, since award of the LEM and TFX fighter contracts, has hired 1000 new personnel.

Venus Temperature Data To Be Released

Release of Venus temperature data from *Mariner II* is now scheduled for mid-March. It was originally to be announced in February. Delays in interpreting data forced postponement.

NASA Mission for Titan III Denied

NASA officials deny reports that they have given the Air Force a mission requirement for the *Titan III* booster. They also deny reports circulated by the Air Force that a meeting was held at Marshall Space Flight Center between NASA and *Titan III* project management. However, use of the booster by NASA could become a reality if a joint AF-NASA *Manned Orbiting Space Station* program, now under consideration by the Administration, is approved.

INDUSTRY

U-2 Is Used to Test Agena Chutes

Recovery parachutes for *Agena* military payloads are being tested by air drops from a Lockheed U-2 specially fitted with a bomb bay in which to carry the dummy payload. Drops are being made from 70,000 ft. Operational opening altitude for *Agena* parachutes is just under 100,000 ft.

UAC Studies EB Welding for Space

Use of electron-beam welding for fabrication or maintenance of vehicles in space is under study by Hamilton Standard division of United Aircraft Corp. The two-year, $340,000 program, under a contract with Air Force Aeronautical Systems Div., includes design of new experimental equipment for space use. This is believed to be based on the Hamilton-Zeiss high-energy electron-beam process. The Air Force decided to move ahead with EB weld studies after looking at laser beam welds, hard-vacuum solid-state joining and fusion methods using optically focused solar energy.

LPC Becomes Division of Lockheed

Lockheed Propulsion Co., formerly a wholly-owned subsidiary, has been made a full division of Lockheed Aircraft Corp. Simultaneously, LPC president Robert F. Hurt was elected a corporate vice president. This all adds up to increased Lockheed emphasis on solid-propellant rocketry.

INTERNATIONAL

U.S. Navy Studies Ikara Missile

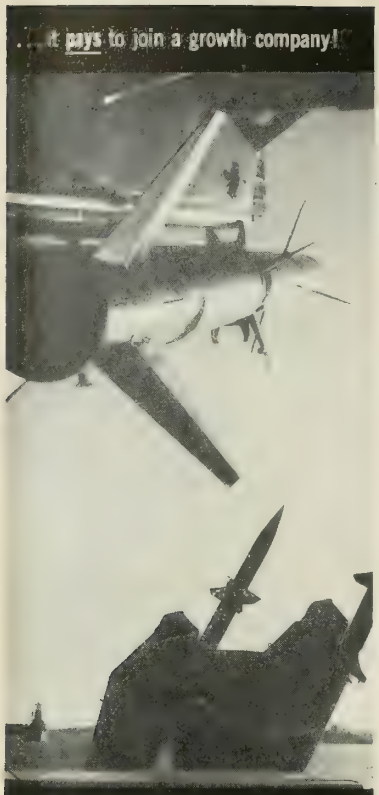
Both U.S. and British navies are said to be considering use of the *Ikara* antisubmarine missile developed jointly by the U.S. and Australia at the Weapons Research Establishment, Woomera. Tests are described as highly successful.

Japan Considering Long-Range Bomarc

Reports from Tokyo say the Japanese Defense Agency soon will re-examine the possible introduction of long-range *Bomarc* missiles as a replacement for manned fighters in its Air Self-Defense Force. The group takes delivery next January of the last of 200 *F-104J* jet fighters now in production. Decision is expected to favor further *F-104* production, not the *Bomarc*.

Australia Gets Its First Bloodhounds

Australia's first surface-to-air guided missile unit, the Bristol/Ferranti *Bloodhound* installation at Williamstown, New South Wales, has been formally handed over to No. 30 Squadron, Royal Australian Air Force. The unit is the *Bloodhound* Mark 1 system, already in use in Britain and Sweden.



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The Missile/Space Week

Fairchild Named for MDS

Fairchild Stratos Corp. will build NASA's giant *Meteoroid Detection Satellite (MDS)* for launch by late 1964. The firm will design and construct two flight models of the craft.

Estimated value of the contract is $5 to $10 million.

The two-ton satellite will be launched on the eighth and ninth *Saturn* test-vehicle flights as part of the expanding meteoroid-detection study directed by NASA's Office of Advanced Research and Technology.

Orbit is expected to range from 300 to 800 mi. altitude. A lifetime of at least a year is planned.

During launch from Cape Canaveral, the satellite will be housed in the 10-ft.-dia. *Apollo* service module which *Saturn I* will carry atop its *S-IV* second stage. *MDS* will be deployed after injection into orbit and separation of the command module and part of the service module.

In orbit, the *MDS* will remain attached to the *S-IV* and will deploy two flat wings—each 10 ft. wide with a total span of 96 ft.—by a system of scissor-like links driven by an electric motor. The wings will be covered with thin sheets of aluminum of varying thicknesses—up to 16/1000 in.—separated by Mylar.

The outer skin is electrically charged, making a huge capacitor. When penetrated by a meteoroid, the material removed by the impact is vaporized, forming a conducting gas that discharges the capacitor. The pulse is stored in a memory circuit to be transmitted on command to a ground station.

When deployed, the satellite will expose a 2000-sq.-ft. area, as contrasted with the 25 sq. ft. exposed by *Explorer XVI,* launched from Wallops Station Dec. 16.

AF Plans Active Space Role

The Air Force has no intention of building its space programs solely on spin-off from NASA projects, Gen. Curtis LeMay declared in a recent speech in Chicago.

The Air Force chief of staff said that if the Air Force can hasten advancement of military space efforts it will do so.

The general stressed what he termed "collateral efforts" as a desirable way for the military to pursue its space programs. "Given a . . . vehicle such as *Gemini,* which is going to fly for others anyhow, we can do collateral testing," he explained.

LeMay warned against considering military space efforts in terms of automated, unmanned devices. He said certain military items that may "ultimately be designed for application to unmanned space vehicles are much easier to test in their earlier phases with an intelligent and technically trained man present."

'Beyond Reasonable Doubt . . .'

Defense Secretary Robert S. McNamara has reiterated Administration confidence in the complete removal from Cuba of all Soviet offensive weapons.

McNamara said he is satisfied "beyond reasonable doubt" that the only weapons remaining are purely defensive. In a two-hour televised briefing, he compiled a mountain of documentary evidence refuting charges—mostly from Republican lawmakers—of a new Russian offensive buildup in Cuba.

Defense officials reported that the military services have flown more than 400 reconnaissance flights over the island since July 1 in what they termed "the most intensive reconnaissance effort ever directed at one objective."

NASA Requests MOSS Bids

NASA has taken a major step toward future development of a *Manned Orbiting Space Station.*

The Langley Research Center has invited 18 firms to submit bids by Feb. 26 on design and construction of a prototype six-to-twelve-month four-man life-support system with 2700-cu.-ft. cabin space.

The following firms were invited to submit bids: Boeing Co., Aerospace Division; Ling-Temco-Vought; General American Transportation Corp., M.R.D. Div.; General Electric Co.; Martin Co., Denver Div.; North American Aviation, Inc. (Downey); North American Aviation, Inc. (Los Angeles); Republic Aviation Corp.

Also: United Aircraft Corp.; Whirlpool Corp., Research Lab.; Space/Defense Corp.; Northrop Space Laboratories; Aerojet-General Corp.; The Garrett Corp.; Atlantic Research Corp.; Unified Science Inc.; General Dynamics Electronics Div.; Bendix Corp.

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ots of the Week

A Martin *Titan II* went a record 0 mi. down the Atlantic Missile nge in a Feb. 6 shot from Cape naveral. The Air Force ICBM de- ered the heaviest payload ever d that far by the U.S.

Weight of the GE Mark VI re- ry vehicle was not disclosed, but e nose cone reportedly could have rried the equivalent of 10 mega- ns.

It was the first *Titan II* launch nducted by an all Air Force crew.

• An Air Force strategic missile uadron crew launched an *Atlas* BM Jan. 31 from Vandenberg FB, Calif., in what was described s a routine training shot.

• Another secret space probe ent up from Pt. Arguello, Calif., eb. 1. The Air Force said a *Blue cout* booster was used.

NASA Medal Given to Stoller

Morton J. Stoller, chief of weather nd communications satellite pro- grams for the National Aeranoutics and Space Administration, has been awarded a NASA medal for "outstanding and dynamic leadership."



Stoller heads the space agency's Office of Applications, major headquarters division in charge of *Tiros, Relay* and *Echo* programs.

Administrator James Webb, who presented the medal, praised Stoller for his management of "a complex scientific organization. . . ."

Zisch New Aerojet President

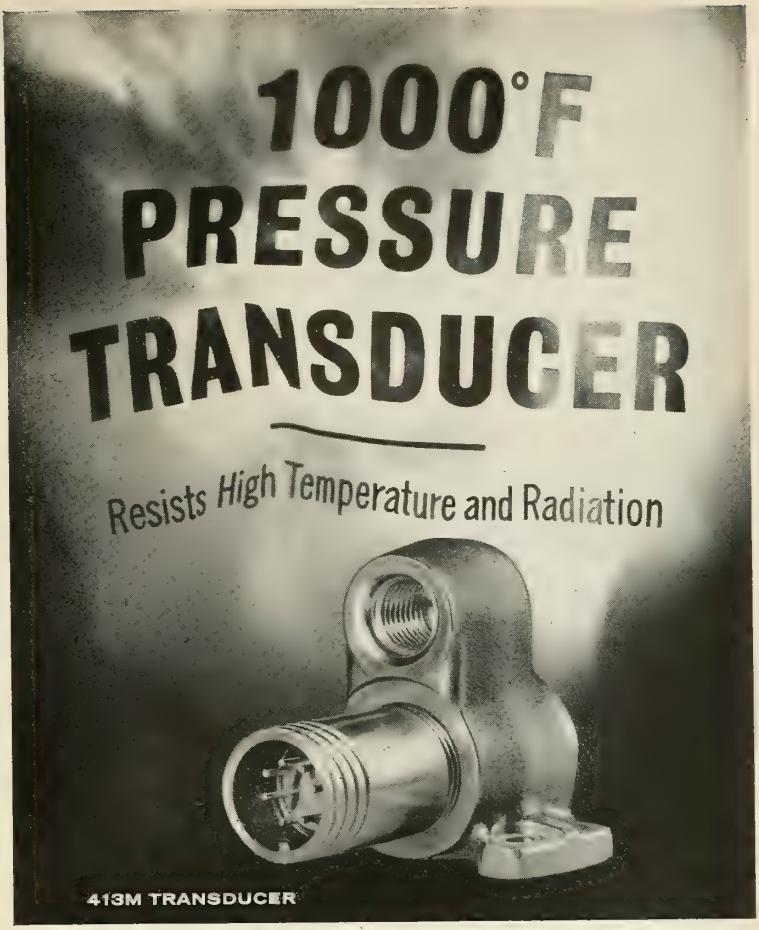
William E. Zisch has been named President of Aerojet-General Corp.

Promotion of the firm's former executive vice president to the new post was one step in a management realignment action announced last week.

Zisch replaces Dan A. Kimball, who moved from the presidency of the firm to become chairman of the board, a position vacated by the retirement of Arthur H. Rude.

At 45, Zisch becomes one of the youngest top executives in the missile/space industry.

In announcing the changes, Aerojet also noted that its 1962 sales and profits were the highest in the firm's 20-year history. Sales for the past year totaled nearly $605 million, and profits before taxes topped the $27-million mark.



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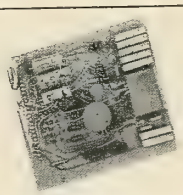
Ambient Temperature Variation of Transmitter: —65° to 700°F: ±2.0% Full Scale; —65° to 1000°F: ±3.5% Full Scale; Units can be calibrated more accurately at a specified temperature.

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Potential blacklist . . .

System Will Rate Contractors

Government-wide list will result from DOD-NASA plan due to take effect soon; incentive contracts boosted

by Hal Taylor

A SPECIAL NASA-DOD committee is setting up a joint rating system which will eventually provide government-wide evaluation of contract performance by missile/space firms.

The system—which could have all the earmarks of a blacklist for some firms—is expected to be operational in about two months.

Its primary purpose will be to provide a central point where past contractor performance will be recorded on an official form.

It is certain to have a wide impact on industry. Besides making consideration of the reports mandatory for all DOD and NASA source evaluation boards before selecting future contractors, the two agencies plan to make the information available to any other government agency wishing to use it.

The new Contractor Performance Rating System was revealed to MISSILES AND ROCKETS by Ernest W. Brackett, director of NASA's Office of Procurement and Supply.

"It will be just like pulling a Dun & Bradstreet report on a contractor's performance," Brackett said.

The plan was first considered by a committee in the office of John Rubel, Assistant Secretary of Defense for Research and Engineering, Brackett disclosed. "We joined the effort later," he said.

Existence of the proposed system was confirmed by both DOD and space agency officials, who said the committee had been working on the problem for about four months.

• **Limitations**—Walter Sohier, who represents NASA on the committee, said the rating system will apply only to engineering and systems research and development contractors—it would not apply to small study contracts.

There will also be a monetary limit, with the system applied only to those DOD contracts worth a total of $20 million with annual expenditures of $5 million.

Sohier said that the NASA limits will differ considerably from DOD's. For example, the monetary value of contracts included in the rating system by the agency probably will be lower.

Evaluation probably will be carried out on a yearly basis. Firms will be rated separately on each contract falling under the scope of the system. The officials made it clear that they do not plan to rate a contractor on what kind of a company it is. Instead, they intend to evaluate it strictly on how well it performs the work included in a specific contract.

"We will look at what the contractor promised to do when the awards were made and then at how well he came through," Sohier said. This will include such important items as meeting of schedules, cost over-runs, and whether the completed product equaled the technical requirements laid down in the original specifications.

Evaluation of the contractor's performance will be made by the DOD or NASA official responsible for management direction of the project.

There is also a possibility that each agency will set up special offices whose job would be to review the evaluation reports to insure that they were impartial.

In commenting on the system, one DOD official said it should make incentive-type contracts more attractive to contractors. Another pointed out that the system will replace the hit-or-miss procedures now practiced in contractor evaluation. "Most of the information we get now," he said, "is by word of mouth."

• **Two-phase experiment**—In other contracting and procurement developments, Brackett said NASA is currently experimenting with a new two-phase source selection procedure that the agency expects to make greater use of in the future (M/R, Nov. 26, p. 49).

In the first phase, firms wishing to bid on a specific project are required to submit information as to what their facilities are, personnel makeup, where the development will take place, and who will head the project.

NASA will then select the two or three firms which it feels are capable of successfully performing the contract. These firms will next be asked to submit technical and cost proposals. Another new wrinkle being considered by NASA calls for paying the selected firms the cost of actual design work included in their proposal.

The agency procurement chief also emphasized that NASA is continuously trying to put more emphasis on incentive-type contracts. ⁂



Big MDS To Be Built For NASA

Fairchild Stratos Corp. has won a contract to build two flight models of the Meteoroid Detection Satellite, shown here in a NASA artist's concept. The first of the two-ton satellites is to be launched aboard a Saturn by late 1964 (see p. 10).

At AF medicine meeting . . .

Military Space Given New Emphasis

AFSC-sponsored session stresses contribution to spaceflight experience; 'biotelescanner' unveiled

by Heather M. David

BROOKS AFB, TEX.—The Air Force rolled out more ammunition in its campaign for an enlarged space role here with an impressive display of military bioastronautics research and technology.

The Fourth Annual Lectures in Aerospace Medicine, given by the Air Force Systems Command at the Aerospace Medical Center, heavily underscored the military's contribution to spaceflight experience, and outlined the desired shape of its future. Even two NASA talks on *Apollo* and *Gemini* were presented in a session entitled "Manned Orbital Development Station," decidedly an Air Force appellation.

Maj. Gen. Osmond J. Ritland, deputy to the commander for manned spaceflight, AFSC, told the group of about 400 space medicine experts that the military man is uniquely suited to space travel because of his readiness to face danger and endure discomfort. He pointed out that besides reasons of national security, military outposts have been the first marks of civilization in previously uncharted territory.

• **More Blue Geminis wanted**—Gen. Ritland said the Air Force is interested in funding about six additional *Blue Geminis*. NASA has programmed 12, which would carry the program well beyond its 1966 cutoff date.

The Air Force would add sensors for inspection and surveillance of other spacecraft, and emphasize operational procedures such as rendezvous and docking techniques. This program might bear an AF price tag of $200 million to $300 million in the next few years. The *Blue Gemini*, he said, might be modified by cutting a door in the heat shield to allow egress by an astronaut to study his capabilities alone in space. Studies are now being run on the feasibility of this idea.

Ritland said *Dyna-Soar* would not be shoved aside by the entry of the military into the *Gemini* program. The need for learning about lifting re-entry extends well into the 1970's.

Gemini could be put on a *Titan III* booster with a transtage, leading eventually into the *MODS* concept. He remarked that a small, two-to-four-man vehicle with capability of more than two weeks could be boosted by a *Titan III* and is well within the state of the art. "All we need is program approval," he said.

• **Aeromedical work**—During the week, four airmen entered the School of Aerospace Medicine's 8-by-20-ft. space cabin simulator for a 20-day test of the effects of the higher-than-normal concentrations of CO_2 that might occur in emergencies.

The first eight days of the test are being spent in a sea-level, mixed-gas atmosphere. But the airmen will breathe about a 3% CO_2 concentration for four days, while the other four days the atmosphere will have the 0.5 to 1% normal situation.

After an examination and "cooling off" period of four days, the subjects will re-enter the cabin, which will then have an almost-100%-oxygen, 32,000-ft. environment. The two intervals of high and low carbon dioxide levels will be repeated, to see what effect low barometric pressure may have on their responses.

Some knowledge also will be added to the experience with 100% oxygen, which Dr. Billy Welch describes as having caused some "nuisance" problems.

In another paper, Maj. Gen. R. L. Bohannon, deputy surgeon general of the Air Force, warned that high concentrations of oxygen increased danger of radiation damage, while hypoxia actually was a means of protection.

• **New device**—A small gray box that will aid in analyzing solutions—including extraterrestrial life forms or astronaut body fluids—was shown publicly for the first time during the session.

The "biotelescanner," as the Air Force has named it, has about 40 glass tubes that are used in chemical analysis of the solutions put into them. When the unknown reacts with one of the chemicals, it forms a cloud pattern that is scanned electronically, and the data are transmitted to a monitor on a line graph. The graph is then compared with previously recorded patterns for identification.

Great potential is expected for the tool, which may be used as a diagnostic aid to astronauts' health by allowing ground monitors to check blood and urine samples. The same instrument may be taken by the astronaut-scientist exploring new planets.

The 12-lb. box, the size of a table radio, has already transmitted data from Brooks to Wiesbaden, Germany, and Iwakuwi, Japan. ⁂

Schirra Had Blood Disorder After Flight

SAN ANTONIO—NASA doctors here are concerned about a post-flight physical condition astronaut Walter Schirra suffered for some 24 hours after his six-orbit flight last October.

The condition, which was not reported earlier, is called orthostatic hypotension. It is a blood disorder which in its most pronounced forms may result in heart attacks, strokes and death; and in milder cases, dizziness and blackout result.

Although Schirra's case was extremely mild, blood noticeably pooled in his legs and feet when he stood up after being taken aboard the carrier. Systolic blood pressure dropped significantly.

During the Fourth Annual Lectures in Aerospace Medicine last week, psychologist Dr. Robert Voas said space medics are not sure what caused the condition and will keep careful tabs on LeRoy Cooper. Special exercises, drugs and special clothing may be employed if Cooper has the same trouble.

Voas added that astronauts Glenn and Carpenter might have had the same condition, in which case it would have disappeared during the longer post-recovery period.

In another presentation during the session, astronaut Scott Carpenter described the new Lunar Excursion Module trainer now being designed. He said it will have a main propulsion system that will carry all but 1/6 of its weight, and thus simulate the buoyancy and rate of fall that it would have on lunar landing. Auxiliary power systems will be operated to guide it to landing.

Six New NASA Flight Projects Funded

Mariner Mars/Venus lander, Advanced OSO among satellites and spacecraft involved; Centaur speeded

THE $891.2-MILLION Fiscal 1964 R&D budget request of NASA's Offices of Applications and Space Sciences includes funds for six new satellite and spacecraft programs.

Funding of $136.5 million for the Office of Applications and $754.7 million for the Office of Space Sciences will provide for the *Advanced Solar Observatory (OSO), Atmosphere Monitor, Ionosphere Monitor,* the *Advanced Synchronous Communications Satellite, Mariner* Mars/Venus landers, and the *ANNA* geodetic satellite.

In addition, over 10% of the total request for both major program offices is earmarked for stepped-up development of the *Centaur* upper stage, which will serve as a booster for advanced projects for both areas.

The $110.7-million request for the liquid-hydrogen upper stage includes $93.6 million for vehicle development, $5 million for engine development, and $12 million for support services.

The funds are designed to meet an operational target date of late 1964 or early 1965. The Fiscal '64 funds will be used to pay for a greatly intensified reliability and quality assurance program, additional ground testing, and tests of flight vehicles and major subsystems under simulated space conditions. Most of the engine development funds will cover continuation of the engine throttling program at Lewis Research Center.

• **New faces**—One major new spacecraft project is the *Mariner* Venus/Mars lander. While some money was provided for the program in Fiscal '63, most of it was diverted to a far lighter *Mariner* for 1962 and 1964 missions. The $43.4-million Fiscal '64 request will start procurement of flight and test models.

Provision for the *Advanced OSO* is part of the $17.4-million budget for the solar exploration program. Preliminary design and procurement of long-lead-time subsystems will be initiated. The *ANNA* geodetic satellite program —which the space agency is taking over from DOD—will receive funding of $3.4 million for the spacecraft, and $2.8 million for launch vehicles. Missions will begin in 1964, using the *Delta* booster.

A contractor for the *Advanced Synchronous Communications Satellite* will be selected in the latter half of 1963. A $40-million Fiscal '64 budget request will pay for four satellites and four launch vehicles.

The *Atmosphere* and *Ionosphere Monitor Satellites* are included in the $20.6-million request for *Explorer* and *Monitor* programs. Development of the *Atmosphere Monitor* will begin in Fiscal '64, with initial launching scheduled for 1965. Sent into a polar orbit, it will be capable of monitoring the atmosphere at all latitudes. The *Ionosphere Monitor* also will be launched

Official Breakdown of NASA's $891.2 Millio

	FISCAL '63	FISCAL '64
Office of Space Applications		
Meteorological Satellites	**57.3**	**63.7**
Supporting Research & Technology		
Synchronous Meteorological Satellite	.3	.95
Advanced Meteorological Sensor Development	.95	3.2
Meteorological Systems Research	1.6	2.45
Advanced Meteorological System Component Development	1.6	3.6
Tiros		
Spacecraft and Subsystems	5.5	2.0
Data Acquisition	4.1	1.6
Engineering Utilization of Data	1.4	1.3
Launch Vehicles	10.2	2.3
Nimbus		
Spacecraft and Subsystems	21.2	31.5
Data Acquisition	2.4	4.0
Launch Vehicles	6.6	8.2
Meteorological Sounding Rocket Systems		
Experiments, Equipment and Support for Large Rockets	.79	1.4
Large Rockets	.27	.36
Small Rocket Systems	.26	.7
Communication Satellites	**43.7**	**51.1**
Supporting Research and Technology		
Advanced Synchronous Satellite Studies	5.0	
High-gain Reflective Structures	.45	.2
Advanced Passive Satellite Studies	2.7	1.2
Intermediate-Altitude Satellite Studies	2.0	2.0
Electronically Steerable Antennas	.23	.1
Isotope Thermoelectric Power Supply Studies Technical & Operational Studies	2.4	1.3
Echo		
Data Reduction & Analysis	.45	.2
Relay		
Ground Station Operations	1.68	1.1
Planning and Documentation	1.2	.35
Communication Rentals	.1	.17
Data Reduction & Analysis	.27	.22
Syncom		
Spacecraft	3.4	.5
Range and Range Rate Equipment	.78	.4
Ground Station Support and Environment Test	3.8	2.2
Data Reduction & Analysis	.86	.87
Advanced Synchronous Communications Satellites		
Atlas-Agena Launch Vehicles (four)	2.2	12.5
Spacecraft (four)	2.3	16.6
Equipment for Ground Stations	1.1	4.96
Ground Station Operations		1.0
Reliability Studies		.5
Switching Circuit		.3
Telemetry and Command Stations		.6
Range and Range Rate Equipment		2.0
Services & Rentals		.5
Data Reduction & Analysis		1.0
Advanced Application Satellites	**.8**	**1.0**
Industrial Applications	**2.37**	**3.5**
Office of Space Sciences		
Geophysics & Astronomy	**144.5**	**194.4**

in 1965 by the *Delta* booster.

Details of the budget requests of other major projects in both program offices include:

• **Ranger**—The $90-million request for the *Ranger* hard-landing series includes $48.3 million for the spacecraft and $41.7 million for the *Atlas-Agena* boosters.

Part of the spacecraft funds will be used to pay for new payloads for launches in 1964 and 1965.

Payloads being considered for these flights include a seismometer hard-landing capsule similar to the one flown on *Rangers III-V* or the television package which will be flown on *Rangers VI-IX*. Another payload now undergoing preliminary development is the hard-landing photo-reconnaissance capsule (see TECHNICAL COUNTDOWN, p. 21).

Among major subcontractors involved, the Aeronutronics Division of Ford Motor Company supplied the hard-landing capsules for *Rangers III, IV,* and *V,* and the Radio Corporation of America will furnish the high-resolution television package scheduled for flight on the next four *Rangers*.

• **Surveyor**—Total budget request for the lunar soft-landing series is $37.5 million for the *Surveyor* lander spacecraft, $18 million for the lunar orbiter and $42 million for launch vehicles.

The Fiscal '64 funds will pay primarily for extensive systems tests of the spacecraft and production of the first flight units. Included will be thermal vacuum tests, shock tests, tethered tests with the propulsion system operative, simulation of the entire mission profile in the environmental chamber, and field tests in the California desert, where the spacecraft will be operated by radio command. Also in the same fiscal year, tests of the critical lander subsystems will be conducted on *Centaur* development flights. These tests will check out spacecraft separation, structural dynamics, the vernier engines and the radars, the attitude control system and the mid-course maneuver.

udget for Applications and Space Sciences

Supporting Research & Technology		
Geophysics	10.1	9.5
Solar Physics	1.3	2.0
Astronomy	1.4	3.0
Interdisciplinary Space Sciences	.77	.7
Flight Projects		
Explorer & Monitors	9.3	11.8
Launch Vehicles	11.2	8.8
Orbital Geophysical Observatories		
Spacecraft	27.5	39.6
Launch Vehicles	11.0	2.22
Geodesy		
Spacecraft		3.4
Launch Vehicles		2.8
Orbiting Solar Observatory		
Spacecraft	8.6	12.6
Launch Vehicles	2.7	4.8
Orbiting Astronomical Observatory		
Spacecraft	31.8	37.8
Launch Vehicles	4.3	15.1
International Satellites		
Spacecraft	2.3	1.5
Launch Vehicles	10.5	5.5
Sounding Rockets & Geoprobes	11.5	13.3
Lunar & Planetary Programs	221.1	322.6
Supporting Research & Technology		
Lunar	4.5	3.89
Planetary & Interplanetary	15.7	16.1
Ranger		
Spacecraft	44.1	48.3
Launch Vehicles	34.8	41.7
Surveyor		
Lander	48.29	37.5
Orbiter	1.7	18.0
Launch Vehicles	11.7	42.0
Mariner		
Mars Flyby	24.3	31.4
Venus/Mars Landers	18.2	43.4
Atlas-Agena Launch Vehicle	5.1	15.6
Centaur		9.7
Pioneer		
Spacecraft	3.5	10.0
Launch Vehicles		5.0
Bioscience	21.0	35.2
Supporting Research & Technology	10.0	10.8
Spacecraft	8.75	11.7
Atlas-Agena Launch Vehicle	2.2	12.7
Launch Vehicle Development	108.0	130.7
Supporting Research & Technology	2.0	5.0
Centaur Development		
Vehicle Development	82.3	93.6
Engine Development	2.7	5.0
Support Service	7.8	12.0
Operational Support		
Product Improvement and Production Testing	7.7	10.9
Maintenance of Ground Support Equipment	1.2	2.1
System Engineering		2.0
Facilities, Training & Research Grants		
Facilities	10.0	18.0
Training	15.0	25.0
Research	5.6	12.0
Total Personnel & Installation Costs	67.45	89.0

• **Surveyor orbiter**—This is being designed to be launched into close orbits about the Moon, where it will serve as a lunar reconnaissance system. Its stereo television cameras will provide broad area surveys of the lunar surface and a basis for initial selection of landing sites for future unmanned and manned lunar spacecraft.

Fiscal '64 funds will initiate the spacecraft hardware development phase —systems tests will begin in early 1964. This will permit the test and evaluation program to be carried out prior to the first orbiter mission, now planned for mid-1965.

• **Mariner**—The $100-million research and development request for *Mariner* includes $31.4 million for Mars flyby missions in late 1964 and $43.4 million for the Venus/Mars lander spacecraft. Another $15.6 million is earmarked for *Atlas-Agena* launch vehicles and $9.7 million for *Centaur,* which will be used in later flights.

Funding for the Mars flyby capsules will provide for system assembly and tests, purchase of hardware for the flight spacecraft and spares, initiation of checkout of flight hardware, and purchase, assembly and checkout of GSE.

This mission will probably include such experiments as ultraviolet spectroscope, a magnetometer, and an infrared spectrometer which would search for organic molecules on the Martian surface. The spacecraft will also carry an optical system capable of taking and transmitting photographs of the terrain.

The funding for the spacecraft carrying re-entry capsules to land on Mars and Venus will be in the purchase of spacecraft and ground support equipment for testing, the assembly of the proof-test model, and the procurement of flight models.

• **Communications satellites**—Most of NASA's funding in the communications satellite area will be used for studies of the advanced synchronous orbit satellite.

The $140-million request will be used for spacecraft development, operational support, ground station operations, reliability studies, switching circuit, telemetry and command stations, equipment for ground stations, range and range rate equipment, data reduction and analysis, and incremental funding for *Atlas-Agena* launch vehicles.

• **Meteorological satellites** — Most of the $63.7-million request is concentrated in the *Nimbus* program. Almost $44 million has been requested for the first Earth-oriented weather satellite—$31.5 million for the spacecraft, $4 million for data acquisition and $8.2 million for launch vehicles. ❖

An M/R exclusive . . .

Thermionic Cell Generates A-C Power

Ford Instrument device exploits internal pulsing, hence needs no inverters and may be step to space solar-thermionic system

by William Beller

LONG ISLAND CITY, N.Y.—An advanced solar-thermionic system for space moved closer to reality last week with disclosure of a thermionic cell able to generate alternating current.

Under test for the past six months, the cell is pulsed internally. This means it does not need inverters—energy and weight consuming components—to change d-c to a-c.

An added advantage is that the cell operates at relatively low temperatures —about 1250°C compared with the usual operating temperature of 1800°C for the emitter of most other thermionic units. The a-c cell, as a consequence, could extend lifetimes and reliability of thermionic converters.

The key to the cell's production of a-c is its low-temperature operation. This mode permits a voltage pulse to readily extinguish as well as fire the unit.

• **Based on proven design**—Except for a pulsing circuit, the a-c cell is identical with the low-temperature, wide-gap d-c cesium cell disclosed by Ford Instrument Co. 18 months ago (M/R, July 31, 1961, p. 24). At that time the company had no life data on its cell. At this writing though, a Ford Instrument low-temperature d-c cell has run continuously for nearly 3600 hrs. and is putting out nearly one watt of power at a power density of about 3 watts/cm^2.

The company has thus devised an a-c thermionic converter; it is based on a d-c design that in prototype has already run for about five months and shows no sign of faltering.

• **Many advantages**—Space vehicles using solar power employ inverters to change the produced d-c power to a-c. Reason is that the d-c voltage is too low to be used as it is, and has to be stepped up. The only efficient way to do this is to convert d-c to a-c and then pass it through a transformer.

If d-c thermionic cells were used, several units would have to be strung in a series to generate the two or three volts needed to energize an inverter. A hazard is that loss of a single cell could significantly decrease performance of a thermionic converter system.

Low-voltage inverters, moreover, are today notoriously inefficient devices. They are considered heavy for space work; furthermore, they must run at relatively low temperatures—a tough requirement in a high-temperature environment.

If, on the other hand, a pulsing current were generated within the thermionic cell, the a-c component could be taken off at the desired voltage by a single-turn primary transformer.

Other advantages:

—More efficient use of solar power because inverter losses are eliminated.

—Uniform power output through the smoothing effect of transformer action.

—A relatively inexpensive and reliable unit for nuclear space-power systems.

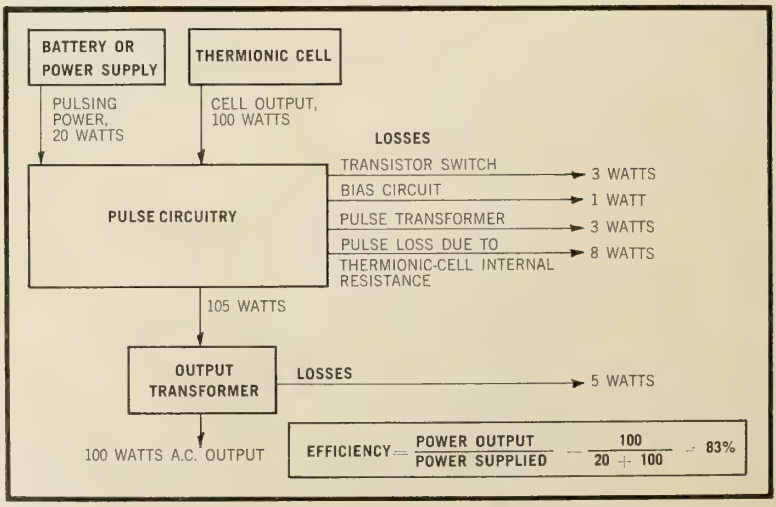
• **Easy switching** — The low-temperature thermionic cell developed by Ford Instrument has the unique power of being readily fired and extinguished.

Most people can use a voltage pulse simply to fire a converter, but they find it difficult to extinguish the converter with a second pulse.

However, because the Ford Instrument unit operates at a relatively low temperature, nearly all the positive ions produced are a result of electron collision, says Michael Silverberg, head of Ford Instrument's thermionics department.

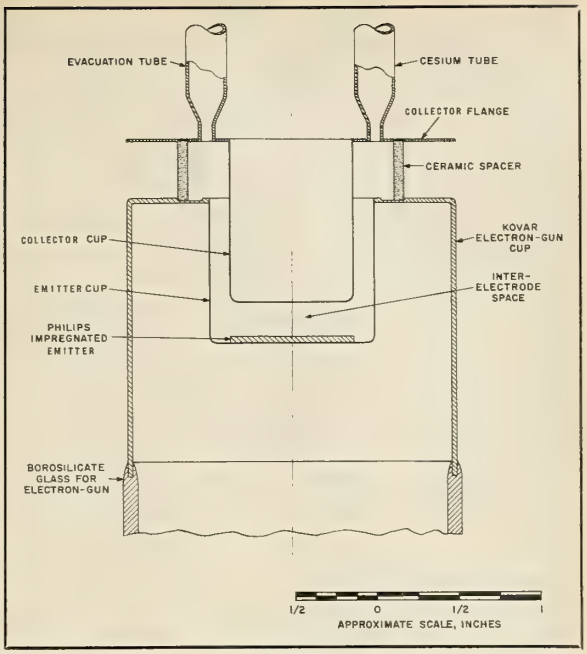
The device is therefore analogous to a gas-discharge device such as a thyratron, and has similar properties: momentarily increasing the applied voltage causes the cell to conduct, while momentarily decreasing the applied voltage causes the unit to stop conducting.

Other thermionic cells, by contrast, are high-temperature devices that produce positive ions by surface ionization. This makes internal switching by an applied pulse difficult, and probably not practical for space applications.



BLOCK DIAGRAM and loss ledger of 100-watt a-c thermionic-converter system.





LEFT: *Assembly of metal-ceramic a-c thermionic cell developed by Ford Instrument.* **RIGHT:** *Cutaway of cell.*

The present Ford Instrument cell uses about 10% to 20% of its power output for pulsing, but Silverberg said there is hope of using a smaller amount of power to do the job.

He also noted that the present cell shows its best efficiency at 400 cps output but that the device has been run up to 1700 cps.

Funding for Ford Instrument's a-c thermionics work comes from the Office of Naval Research, the Air Force Aeronautical Systems Div. and the AF Cambridge Research Laboratories. The company itself has also invested substantially in development work.

• **Low-voltage operation** — Operation of the low-temperature converter is based on setting up an ultra-low-voltage arc between the cell's emitter and collector. An innovation is the use of a gap up to 0.2-in. between emitter and collector—one or two orders of magnitude larger than the gaps used in most other thermionic cells. In practice, the company uses an electrode gap of about 0.1 in.

Silverberg told MISSILES AND ROCKETS that the ratio of collector area to emitter area has a major effect in providing the highly improved performance the Ford Instrument cell has over its competitors. "We find that increasing the ratio to a value greater than one provides a lower voltage discharge and therefore better performance," he said. These high ratios are possible because of the wide spacing of the electrodes.

• **No adequate theory**—There is still no reasonably full understanding of the theory behind the ultra-low-voltage arc converter. However, the process does involve direct electron-produced ionization within the volume of the arc discharge, and does not involve surface effects caused by Langmuir-type ionization.

In the earlier M/R article, the discharge was described as distinguished by a rapidly rising potential within the discharge itself up to a potential maximum. This maximum may be a localized "ball-of-fire discharge" that in some instances fills the entire interelectrode spacing—the Langmuir discharge.

The ion-producing reactions take place inside the reaction zone. The conduction electrons, as well as those that caused excitations and ionization of the neutral atoms, then drop to the collector and complete the circuit.

All of the foregoing characteristics of the ultra-low-voltage arc have been observed during experimental work at Ford Instrument. As the interelectrode gap is reduced below a certain distance —a function of cesium pressure—or if the current density drops significantly, the arc is extinguished.

This phenomenon is said to be consistent with the requirement that a certain number of mean-free patterns exist between the emitter and collector for the arc to be sustaining.

• **Principles of operation**—The a-c thermionic cell, based on the phenomenon of the arc discharge in a cesium vapor, has two modes of operation—an arc mode and a secondary mode.

The arc mode is characterized by a high current density and a correspondingly low internal resistance due to the formation of cesium ions that neutralize the internal space charge; the secondary mode is characterized by very low attainable currents due to an appreciable space charge that results in a high internal resistance.

The a-c cell operating into a load that does not approach an open-circuit condition can be pulsed into and out of the arc mode of operation through the application of momentary pulses of positive and negative voltages. A converter pulsed in this way would deliver a pulsating d-c voltage across its transformer, since the d-c components of current will cancel and prevent saturation of the transformer core.

The transformer secondary may be wound for any desired voltage, thereby permitting the generation of usable a-c voltages from a pair of thermionic converters. The two converters may be combined into a single cell using a common emitter for both collectors. This will result in a more efficient design since standby and end losses will be reduced.

Ford Instrument's successful experiments with pulsing circuits are pointing the way to development of an improved cell for use as a practical a-c thermionic generator. The company is currently building experimental cells able to operate in a dual-collector mode and incorporating other experimental features.

The company also is pursuing system design which uses a-c thermionics. ⌘

Specific Career Positions at NASA

Outstanding Opportunities Available Immediately At NASA Centers in Maryland, California, Texas, Alabama and Ohio

The career positions outlined below bear a direct and significant relationship to the nation's space effort.

Respondents should have a BS or advanced degree from an accredited college or university. Please send your inquiry to the Personnel Officer of the appropriate NASA center, as indicated below.

NASA GODDARD SPACE FLIGHT CENTER

Dept. NB-1, Greenbelt, Maryland (Suburb of Washington, D. C.)

Satellite Tracking

Various positions at beginning through senior level involving research, design and development of optical and electronic devices and systems. Also, openings in Systems Analysis and Evaluation and in management of Overseas Tracking Stations. BS or higher in EE, Mathematics or Physics preferred.

Communication & Data Acquisition Program Management

Technical management for development of satellite communication and data handling subsystems. Positions require laboratory experience in design of miniaturized electronic flight hardware.

Systems Analysis

For evaluation and systems design of complex data processing facility utilizing special purpose telemetry reduction equipment and large scale digital computers. Background in computer systems design, digital computer programming or data analysis.

Spacecraft Heat & Light Control

Development of thermal analysis techniques; thermal design of spacecraft; design and development of passive and active temperature control systems; research on coatings with precise optical properties; development of techniques for rapid and reliable measurement of optical properties in infra-red, visible and ultra-violet. Involves consideration of effects of the space environment, including vacuum, ultra-violet irradiation, electron and proton bombardment and thermal stress.

Electronic Flight & Support Systems

Design, coordination and integration of all electronic subsystems for satellites. Beginning through senior level openings for Electronic Systems Engineers.

Space Vehicle Project Management

Rocket launching, analysis and evaluation of rocket vehicle flight performance. Includes development of techniques for acquiring and evaluating data, design and modification of rockets for specific payload requirements, trajectory studies, stress and vibration analysis and technical management of rocket vehicles. Beginning through senior level openings for Engineers, Physicists, Mathematicians.

Flight Systems Test

Test and evaluation in areas of stress, magnetics and vibration. Beginning through senior level openings.

NASA FLIGHT RESEARCH CENTER

Dept. NB-1, Edwards, California

Automated Control Systems

Plan and conduct research, design, modification and development work in application and instrumentation systems required for vehicle guidance, control and navigation purposes. BS in EE, Electronics option preferred. Three years' experience in design and development of control and guidance hardware.

Radio Frequency Systems

Airborne vehicle tracking, data acquisition and data transmission. BS in EE, Electronics option preferred. Three years' experience in tracking, data acquisition and data transmission. Digital machine experience at design level required. Telemetry and communication experience desirable.

Supersonic Aerodynamics

Parametric studies of configuration components as related to lift, drag and stability characteristics. Evaluate designs and advise on problems of supersonic and hypersonic configuration aerodynamics. Flow field effects on design—a major consideration. BS or advanced degree in aerodynamics preferred; three to five years' experience in configuration and flow field studies.

Control & Guidance Systems

Conduct tests and evaluations of linear and non-linear control and guidance systems. Consult on systems analysis problems related to human participation and automatic flight control systems. Develop criteria for control and guidance systems analysis, hardware development and flight evaluation. BS in Engineering, Physical Science or Mathematics preferred, including courses in aerospace sciences and mathematics beyond ordinary differential equations. Four years' control and guidance systems design, test or analysis experience.

Reliability & Quality Assurance

Analyze raw parts failure data to establish a numerical reliability of systems and components of the X-15 Research Aircraft. Establish reliability prediction techniques—predictive criteria will be applied to future research vehicles. BS in Engineering, with a mathematical capability in statistical analysis and prediction techniques. Experience in reliability engineering groups desirable.

Structural Mechanics

Research in vibration dynamics and structural thermoelasticity. Management responsibility. Select and plan research projects. BS in a Physical Science and five years' professional experience in structural research preferred.

Flight Mechanics

Investigation of the responses of vehicles to forces, flows and associated flight phenomena involving aerodynamic effects, guidance and control systems, etc. BS in Astronautics, Aeronautical or Mechanical Engineering or Engineering Mechanics. Minimum of three years' experience with demonstrated ability to perform high level research.

NASA AMES RESEARCH CENTER

Dept. NB-1, Mountain View, Calif.

Solid State Circuitry

NASA's Space Sciences research programs require engineers to design and develop solid state circuitry for use in scientific instruments in existing and future flight programs. Openings at both intermediate and senior levels. MSEE preferred.

Light Measurement

Includes the design of optical, telescope, and spectrophometers for infra-red and ultra-violet astronomical observation. Applied physics or optical engineering background.

Satellite Instrumentation Packaging

Includes the design of minimum weight structures for the packaging of circuits and instruments and for thermal and stress analysis of these structures. Openings at intermediate and senior levels. BSME or MSME preferred.

NASA MANNED SPACECRAFT CENTER

Dept. NB-1, Houston, Texas

Space Sciences

Physicists experienced in Geodesy, Astronomy, Astro-Sciences and Geophysics for work in developing manned spacecraft mission, including simulation of space environment for Projects Gemini and Apollo. Intermediate and senior level openings.

Propulsion & Power

Aeronautical engineers experienced in liquid and/or solid propulsion with emphasis on nozzle design, flow patterns, gas dynamics and spacecraft design. Intermediate and senior level openings.

Fluid & Flight Mechanics

Mechanical Engineers experienced in thermo dynamics, heat transfer, thermal control, fluid flow, landing systems (parawing, rotor systems, parachute) and spacecraft components. Intermediate and senior level openings.

Data Acquisition Systems

Electronic Engineers experienced in data acquisition, computer operations, computer programming, and control and guidance systems. Intermediate and senior level openings.

NASA LEWIS RESEARCH CENTER

Dept. NB-1, Cleveland, Ohio

Propulsion Components & Systems

Experience with cryogenic tanks and valves, turbo-machinery, dynamic controls, thrust chambers, gas generators, heat exchangers, systems analysis and systems testing. Research on heat transfer, lubrication and bearings, fundamental flow processes, tank pressurization and turbopumps. Intermediate and senior level openings.

Reliability & Quality Assurance

Analysis and appraisal of specific hardware and systems designs. Develop standards to judge reliability and performance, together with appropriate test plans for materials and equipment rating. Establish procedures and systems to assure conformance of hardware and equipment to specifications. Failure analysis of defective components and systems.

Facilities Engineering

Design and construction of large scale engine test and space environment facilities; analyze test requirements; develop test chambers, support systems, handling facilities, operating techniques; instrumentation and control systems for specific tests. Beginning to senior level openings.

Project Development Engineering

Engineering analysis of project requirements; develop schedules and test plans; analyze test results, contractor reports, project review data; liaison with contract representatives and other technical management responsibilities.

Mission Analysis & Application

Analysis of mission requirements in terms of flight paths, orbits, payloads, propulsion, control, and guidance; configuration and matching studies of vehicles, boosters, and their combinations; energy management studies, studies related to orbital rendezvous and landings on planetary bodies. Beginning to senior level openings.

Vehicle Structures

Conceive and design vehicles to meet particular space flight requirements. Includes structural analysis, size and weight studies, systems layout, power and propulsion requirements, materials selection.

Ground Support Equipment

Design and development of ground support systems for checkout and launching of specific payloads and stages.

Nuclear Propulsion & Power Systems

Scientists and Engineers skilled in Nuclear Reactor Technology, radiation and shielding, materials deterioration and nuclear rocket heat transfer studies. Other work specialties concerned with the operation and performance of experiments in a 60 megawatt experimental test reactor at our Plum Brook Station at Sandusky, Ohio. Intermediate and senior level openings.

Space Power Generation

Mechanical, fuel cell and solar cell systems. Research Engineers and Physicists skilled in liquid metals technology, magneto-hydrodynamics, refractory coatings, turbomachinery, fluid dynamics and heat transfer, electric generators, power conditioning, thermionics, physical metallurgy and fabrication, environmental testing, system controls. Research on direct conversion of thermal, solar or nuclear energy to electrical energy. Involves semiconductor and plasma energy conversion devices. Beginning to senior level openings.

NASA MARSHALL SPACE FLIGHT CENTER

Dept. NB-1, Huntsville, Alabama

Automated Control Systems

Research in Theoretical Physics, Aerodynamics and Mathematics including establishing trajectory for space vehicles and evaluating flight mechanical parameters. Also will include pre-flight and post-flight evaluation of space vehicle or spacecraft flight and systems. Beginning and senior level openings. BS or MS in Physics, Mathematics or Aeronautical Engineering preferred (min. 20 semester hrs. in Physics).

Fluid & Flight Mechanics

Solution of advanced theoretical space vehicle and spacecraft problems in one or more of these areas: Aerodynamics, Flight Mechanics, Guidance and Control and Vehicle Performance with emphasis on system conceptualization. MS or PhD in Physics, Mathematics or Aeronautical Engineering preferred.

Space Sciences

Participate in space vehicle and spacecraft theoretical atmospheric physics studies in one or more of these areas: Wind Turbulence, Wind Shear, Model Atmosphere and Terrestrial and Space Environmental Conditions. BS or MS in Physics preferred, with min. 20 semester hrs. in Meteorology.

Flight Mechanics

Theoretical research studies for space vehicle in one or more of these areas: Optimization of Space Orbits, Sensitivity of Orbits to Celestial Influence, Development of Analytical Formulation of Space Flight Orbits, Atmospheric Re-entry Flights, Stability and Control of Rigid Bodies, Guidance Control Systems and Flutter and Vibration. BS or MS in Physics, Mathematics or Aeronautical Engineering (min. 20 semester hrs. in Physics).

Measurement & Control Systems

Solution of aerodynamic, electronic and instrumentation problems requiring analysis and evaluation of electronic measurement and instrumentation systems for experimental aerodynamic wind tunnels, space simulators and allied facilities. BS or MS in EE or Physics.

Measurement Standards & Calibration

Theoretical research studies for space vehicle in one or more of these areas: Optimization of Space Orbits, Sensitivity of Orbit to Celestial Influence, Development of Analytical Formulation of Space Flight Orbits, Atmospheric Reentry Flight, Stability and Control of Rigid Bodies, Trajectories and Guidance and Control Theories. Beginning through senior level openings. BS or MS in Physics or Mathematics preferred (min. 20 semester hrs. in Physics).

NASA is an equal opportunity employer. All positions filled in accordance with Aerospace Technology Announcement 252-B.

Technical Countdown

ELECTRONICS

High-Altitude Tracking Platform Built

"Skyscraper," a specially instrumented KC-135 jet aircraft, soon will be employed in missile signature studies. Outfitted by AF Cambridge Research Labs to permit precision measurements of infrared, visible, and ultraviolet radiations emitted during missile flight and re-entry, the craft will be evaluated by MIT's Lincoln Laboratory. Equipment includes a precision tracker and multiple spectrometer capable of covering a broad portion of the spectrum. A 20-30-in. flat mirror in a pressure housing is used on the belly of the craft to reflect radiation to an optical telescope. During tracking operations, a single computer controls both the aircraft and the tracker when measurements are being made.

Short Life Confirmed for Orbiting Needles

The 250 million copper dipole needles involved in the upcoming Project West Ford experiment will have a very short orbiting life, Air Force experts say. The prediction is based on the results of the secret needle orbiting test conducted by the Air Force last year. The six needles proved unaffected by space electricity. Experts had feared that the charge drag effect of electricity in space would cause the needles to shift from their initial orbit, and pressure from the Sun would keep the dipoles in space for years. The six-dipole experiment will be reported in greater detail in the Journal of the American Geophysical Union.

Lunar-Impact Camera Planned

A hard-landing photo-reconnaissance package is being planned as a payload for some of later *Ranger* spacecraft flights. The capsule, upon landing, will take a 360° panoramic picture of the landscape with sufficient detail to identify objects down to 0.2-in. dia. in the immediate vicinity of the instrument.

VIG's Big in Rome Procurement

Announcement of a fourth Air Force order of Video Integrating Groups, valued at $2.3 million, brings to $15 million total AF purchases of the units designed to minimize radar echo clutter. Built by Airborne Instruments Laboratory for Rome Air Development Center, Griffiss AFB, N.Y., VIG's are used throughout the USAF radar defense network. They are reported to have proved extremely effective in reducing the degrading effects on radar scopes of natural and accidental RF interference. More significant however, is VIG use in countering electronic countermeasure techniques such as jamming, electromagnetic "decoys," and chaff.

System Doubles Binary Information Transmission

A duobinary technique perfected by Lenkurt Electric Co., Inc., a subsidiary of General Telephone & Electronics Corp., allows the transmission of information over telephone lines and by radio at speeds up to 3200 words per minute. The system, the company claims, is smaller in size and halves the complexity of present methods. The duobinary doubles the number of bits transmitted each second through a unique signal coding function at the transmitter. Error detection is incorporated directly within the coding technique in some applications, making it possible to check automatically the accuracy of the data as it is transmitted. With typical telephone noise conditions, the system will have an average error rate of one million bits, according to Lenkurt.

Hot Moon

Studies at the Radiophysical Institute, Gorky, USSR, of the Moon's radio emission at wavelengths between 1.5 and 50 cm indicate that the temperature rises with depth. At depths between 15 and 20 meters it is 25°C above that on the surface, and may reach 1000°C at a depth of 30-40 miles.

PROPULSION

X-20 Acceleration Motor Tested

A flightweight, thrust-vector-controlled model of the XM-92 *Dyna-Soar* acceleration rocket went through a perfect firing test at Thiokol's Elkton Division. The XM-92 will power early atmospheric test flights of the *Dyna-Soar* re-entry glide vehicle. Its ultimate use will be as an escape rocket in the event of booster malfunction during launchings of the *X-20*. The hinged nozzles, capable of changing direction on command, functioned as designed in the test.

Noise Facility Operational At Huntsville

A $250,000 acoustic fatigue-test facility capable of reaching sound levels up to 167 decibels is in operation at the Marshall Space Flight Center, Huntsville, Ala. Designed and operated by Wyle Laboratories, the sound-generating lab will be used to investigate materials intended for the *Advanced Saturn* launch complex. Such high sound levels can shatter steel under certain conditions, and the huge *C-5* is expected to reach this extreme noise area. Wyle will also investigate the human factor element of high sound levels.

Better Steel Due for Centaur Tanks

NASA is investigating another type of stainless steel for use in the *Centaur* tankage. Called stainless 310, it reportedly is better suited to the lower temperatures of the liquid hydrogen used to power the upper stage.

SPACE MEDICINE

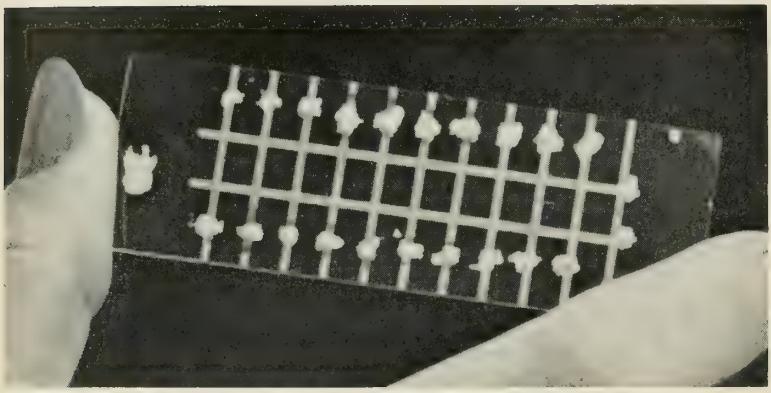
Russians May Computerize Space-Med Inputs

Since the capacity of radiotelemetering channels will be reduced as the duration and distance of spaceflight increase, Russian experts are pondering the use of on-board computers to aid in the medical monitoring of astronauts. The computers would collect information, compare the data with preprogrammed norms, analyze and then transmit results to ground stations. Intensive work is going into the development of small computers and special sensors. Electrocardiography and pneumography were the two methods used in the Gagarin and Titov flights; electro-encephalography, electro-oculography and skin galvanic reflex recordings were added for the Nikolayev and Popovich flights.

GE Working on Tunnel-Cathode Tube

DOD's Diamond Labs backing $110,000 R&D effort based on evidence "cold" tube may be relatively immune to radiation

by Charles D. LaFond



TUNNEL-CATHODE prototypes such as this have been used by researchers at GE's Receiving Tube Dept. in Owensboro to demonstrate electron emission.

OWENSBORO, KY.—A unique vacuum tube, employing a tunnel cathode, is being developed by General Electric Co. for use in space.

After early feasibility studies performed as an in-house project by GE's Receiving Tube Department here in 1960-61, it was determined that such a "cold" tube could offer relative immunity to radiation and an unprecedented opportunity for achieving long operating life at low power.

Now funded at more than $110,000, the R&D effort is supported by NASA through a contract awarded GE last year by the Harry Diamond Laboratories (formerly Diamond Ordnance Fuze Laboratories), Dept. of Defense.

• **Background**—Natural space radiation—that normally present in Earth's near-space Van Allen belts and that resulting from high-intensity solar-flare emissions—severely degrades some electronic components. In particular, semiconductor devices have proven to be highly susceptive to radiation damage, both temporary and permanent.

Although conventional vacuum tubes appear relatively insensitive to such forces, tube power requirements are frequently too high for satellite or general space-vehicle use.

Therefore, Diamond Lab (among others) was searching for an active electronic device for space applications employing the best and most practical design and operating characteristics of tubes and semiconductor devices.

Coincidentally, General Electric/Owensboro scientists had performed extensive company-funded studies of tunneling processes. Results of their preliminary investigations indicated that such an approach offered an excellent opportunity for developing a new practical electron source for vacuum tubes.

In short, they determined that a tunnel-cathode tube could be developed which would be relatively immune to radiation effects, result in smaller units with lower capacitances, operate at room temperature (because of the absence of a heating element), and, it was hoped, achieve emission-current densities of from 10 to 100 amperes/cm^2.

In June 1962, Diamond Labs awarded GE a one-year R&D contract to study the materials problems involved with tunnel cathodes and to develop a practical device using the tunneling mechanism. Total value of the CPFF contract is $92,737. GE will share costs up to an additional 20%, thus bringing the effort total to more than $110,000.

Clifford E. Horton, an advanced development consulting engineer for GE's Receiving Tube Dept., is directing the project.

• **Tunnel emission**—The basic element employed to achieve electron tunnel emission is a conductor-nonconductor-conductor sandwich.

Such a central insulator was previously considered a barrier penetrated only by high-energy electrons. At room temperature, for example, the thermal energy of the electron was believed too low to permit insulator penetration.

The physicist's present view of the electron is somewhat altered. One GE engineer described the present (but greatly simplified) concept this way:

The electron may be considered as something distributed in space, much like an out-of-focus picture, rather than a small, sharply defined orbiting bit of matter. This "space-charge cloud" may be interpreted as corresponding to the probability of finding the electron at a particular point at any given time. For more mobile electrons, this blur could be quite vast in size. Further, there is a definite probability of its moving out to 50 or 100 atoms away from the nucleus of its parent atom.

Thus, in the sandwich emitter, if the insulator is only a few tens of atoms thick there is a small but finite probability that an electron will be found in one conductor substrate while its associated atom is on the other side of the insulator.

Since the number of electrons in a conductor is very large, the current flowing as a result of this electron motion—or tunneling—can be quite large. (In a tunnel diode, for example, the current density produced by electron tunneling has been demonstrated to be normally about 1000 amperes/cm^2.)

If the counter-electrode is made five volts positive with respect to the other conducting layer, a tunneling electron on arriving at the counter electrode would have its initial energy plus an added kinetic energy equivalent to five electron volts.

Also, if the counter electrode is very thin, a few tunneling electrons will pass through and out of it. Thus they are "emitted" and the device is effectively a cathode.

The ideal electron-tunneling configuration—if it were physically possible to construct—would employ a vacuum

as the insulator between two conductors, one engineer pointed out. Problems such as spurious currents due to electrolysis and the dissipation of the kinetic energy of the electron within the barrier region would be bypassed.

The tunnel diode represents a device employing another barrier mechanism. The GE official said the insulating region is actually a thin layer, within a semiconductor, that has insulating properties under carefully produced conditions of impurity concentrations and applied voltage.

• **Materials problems**—Chief problems facing GE developers are with materials and processing—particularly in producing thin films with sufficient density, uniformity and purity.

Electrical requirements for a practical tunnel emitter will be particularly severe, the scientists believe. The thin insulating film, they point out, will experience a voltage stress of about 10^6v/cm. Even for good insulators, dielectric strengths as shown in standard handbooks are low by an order of magnitude.

Also, they stressed that tunneling current density through the insulator varies exponentially with thickness. Thus a larger portion of the total tunneling current would be carried through thin spots in the film.

Best uniformity attained so far has been by anodizing. The method also yields higher dielectric strengths.

Thin-film requirements for the counter-electrode will be similarly stringent. To minimize electron-energy loss during transit through the conductor, the film must be very thin.

Paradoxically, the film must have sufficiently low resistivity to conduct non-emitted electrons away without voltage drops large enough to prevent obtaining a required potential uniformity throughout the counter-electrode. Such conductive films are difficult to fabricate.

Gold films, for example, when vacuum-deposited on glass tend to draw up into tiny globules instead of forming a continuous uniform film.

GE researchers also have found that slowly deposited metals generally tend to form spongy films rather than the dense layers that are required because of their optimum electrical properties.

Some solutions have been achieved through proper selection of materials, use of super-clean vacuum systems and optimum deposition techniques, and employment of exact techniques for maintaining substrate cleanliness.

GE said use of more elaborate geometrical arrangements than the simple conductor-insulator-conductor sandwich structure may solve these and other fabrication problems.

The substrate-conductor requirements, say developers, will be more easily met. The quality of its surface, however, must be very good since smoothness and uniformity of the other two layers will depend on the substrate.

• **Materials studies**—Initial materials research before award of the R&D contract was concentrated on aluminum and aluminum-oxide combinations and in theoretical studies. Researchers felt that the most critical problem—on whose solution tunnel-cathode feasibility depended—was whether or not a thin insulating film could be deposited having sufficient quality.

Once having solved that problem, GE broadened its research into vacuum-anodization techniques and materials, including tantalum, titanium, zirconium, and niobium as possible alternates for anodized aluminum films.

During the remainder of the one-year contract, GE will perform extensive studies of tunneling processes.

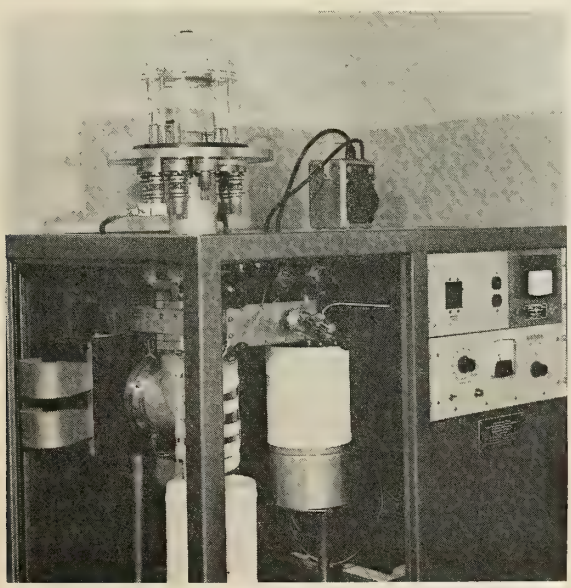
When the quality and repeatability of tunnel cathodes are such that comparative evaluations can be made, a variety of insulating and conducting materials may be combined.

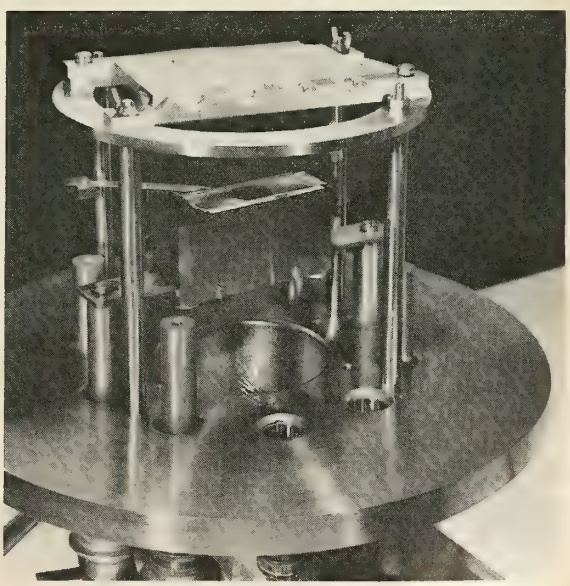
Besides the approaches already mentioned, GE researchers will study oxidation of diffused metals (silver-magnesium or beryllium-copper alloys) and oxidation of metal film (e.g., magnesium oxide on a platinum substrate).

Some tunnel-cathode prototypes are now being tested at the Owensboro laboratory. For control purposes, evacuated tubular enclosures are being employed. Later, metal tube envelopes will be used.

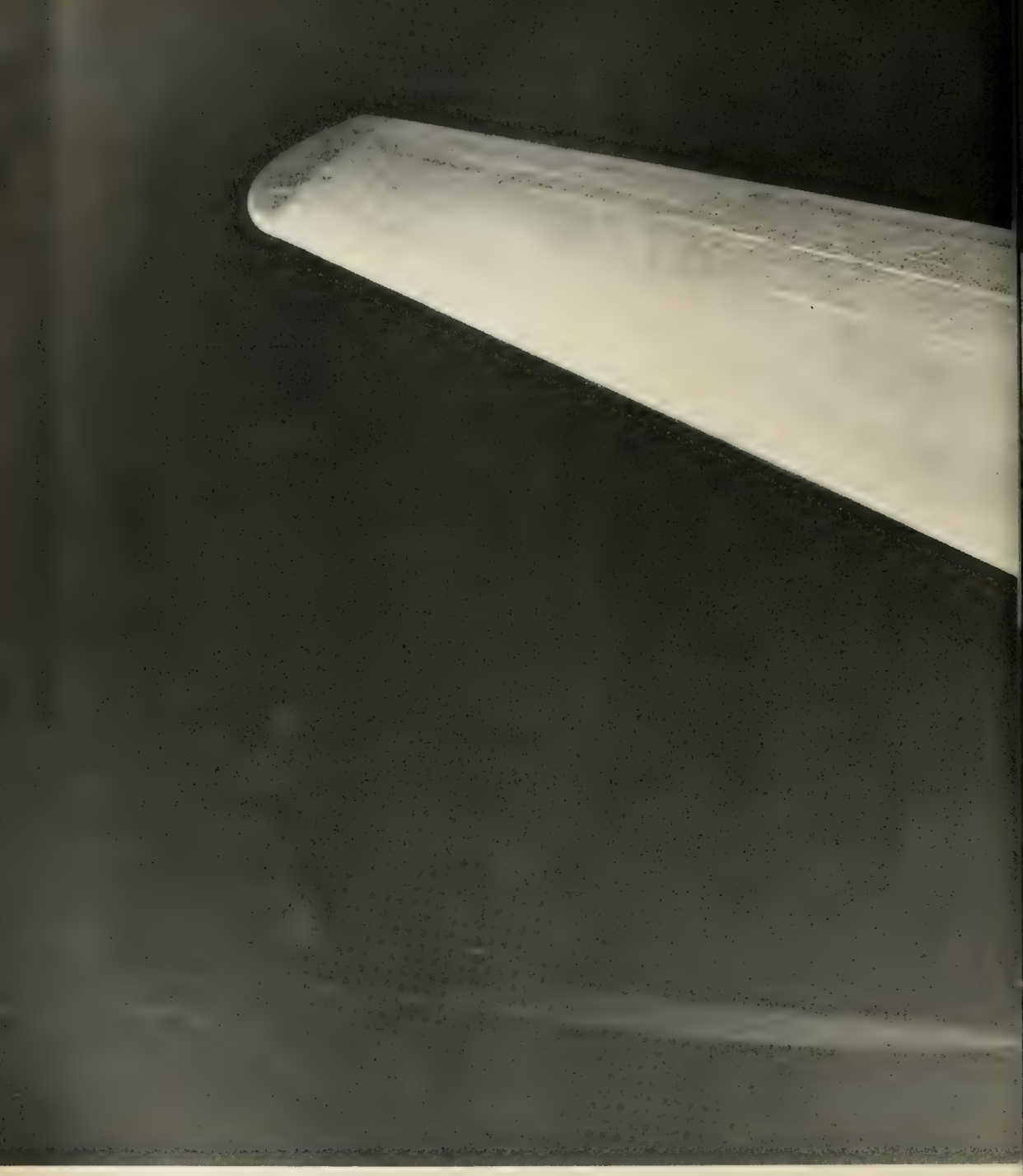
Although much work remains to be done to perfect tunnel-cathode tubes, it's reported that researchers already have achieved emission current densities of from 20-30 amps/cm^2.

Late this month, GE researchers plan to select the most promising materials or combinations of materials for working tunnel cathodes. The remainder of the contractual period will be used to test and further improve the tunnel-cathode elements and tube assemblies. ⁘





LEFT: *This specially built oil-free ion-pumped high-vacuum system is used by GE-Owensboro scientists in developing a tunnel cathode.* **RIGHT:** *Close-up shows work space in vacuum system required for the vapor deposition processes.*



We put 900,000 holes in this wing to make it fly better

You can't see them. But they're there. And they help solve one of the most baffling problems in the history of aviation.

The problem centers around a thin boundary layer of air that flows next to the surfaces of an airplane in flight. This air becomes "turbulent" as it passes over the wings, causing a sharp increase in friction drag – drag that robs the plane of speed, range, and engine power. This turbulence has nothing to do with bumpy air; it occurs even when the plane ride as smooth as silk.

To overcome this problem, Northrop has conducted 14-year research program, and has developed a system call Laminar Flow Control. Row after row of paper-thin slots a put in the wings of an airplane. At the base of these slo are pinsize holes. A pumping system inhales the bounda



yer air through the slots and holes and expels it to the rear. voosh! Eighty percent of the friction drag from boundary rbulence is gone.

Laminar Flow Control will make it possible to extend the nge, endurance, or payload of large aircraft by 50% or ore – with no increase in fuel consumption. Best of all, per- aps, is that it can be added at very nominal cost. And this initial cost is quickly recovered by economies of operation.

Laminar Flow Control is being applied by Northrop to two U.S. Air Force jet aircraft, which will be designated X-21's. These will be flown in 1963 to demonstrate the new technology. Results of these tests should radically alter the fundamental concepts of large plane design, economics, and missions.

NORTHROP

Glider May Be Post-Apollo Guinea Pig

Low-cost program at Flight Research Center aims at subsonic, hypersonic maneuverability

by Russell Hawkes

EDWARDS AFB, CALIF.—Piloted low-speed flight tests of a wingless glider shaped like a maneuverable re-entry vehicle will begin at NASA's Flight Research Center here in March.

Considerable useful information is expected from the boat-shaped wooden craft after the highly respectable success of *Paresev* (Paraglider Research Vehicle), FRC's previous venture into ultra-inexpensive flight research. *Paresev* yielded valuable design data for the paraglider recovery system of the *Gemini* two-man spacecraft.

The total cost of that program, including all expenditures for support, was only about $30,000. The cost of the new program is expected to add up to a similar figure by the time all operating and support costs are in.

• **Maneuverability is goal**—NASA is interested in post-*Apollo* spacecraft with much improved hypersonic and subsonic maneuverability in the atmosphere. By permitting controlled landings at selected sites, these will eliminate present complicated and costly recovery methods. They will need lift-generating bodies with more efficient re-entry characteristics than *X-20 (Dyna-Soar)*.

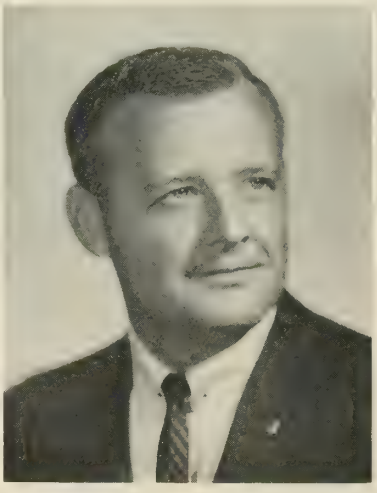
The purpose of flight-testing the wooden model is to measure the ability of a pilot to control such spacecraft/aircraft at low speeds. The shape, designated *M-2*, is one of a series developed at Ames and Langley Research Centers and exhaustively wind-tunnel-tested to measure re-entry characteristics.

Selection of *M-2* as the first shape to be flight-tested at low speeds does not represent a guess by NASA about the best final design of a lifting re-entry body. The role of NASA research centers is to develop design principles by testing families of configurations.

M-2 is thought to have some advantages at low speeds. Since it is that end of the speed scale that is to be investigated, logic dictated choice of *M-2*. Also, as Paul Bikle, director of FRC pointed out, the concept of low-cost flight research is controversial in some quarters, and progression from easy to difficult problems permits simultaneous development and proof of the concept. If procedural troubles are encountered, they can be corrected with minimum cost and embarrassment.

Other re-entry shapes that are candidates for piloted model flight tests include a lenticular (lens-shaped) body developed at Langley, and the *M-1* shape developed at Ames.

The *M-1* is roughly pyramidal, with the apex of the pyramid forward. Wind-tunnel tests indicate it would be excellent for re-entry but not so good for low-speed flight. NASA is now considering addition of an inflatable afterbody to improve its low-speed characteristics.



M-2 GLIDER test pilot Milton Thompson.

Research may reveal a more promising shape than any of those under consideration, and that shape would become a candidate for flight testing as a glider.

• **Design details**—Structure of the *M-2* glider consists of a tubular aluminum "carriage" with fixed lightplane landing gear, a cockpit, and attach points for the wooden aerodynamic shell that fits over it. It was designed this way so that the *M-2* shell can be removed from the carriage and replaced by one of the other configurations.

The carriage has been taxi-tested and drop-tested with ballast at fitting points to simulate the weight of the shell. The carriage, stabilizing fins, and control surfaces were all fabricated at FRC.

Sailplane Corp. of America, responsible for the manufacture of the aerodynamic shell, was given only the loftlines of the *M-2* shape and the attach points for the carriage. FRC engineers had expected to design the shell and its substructure themselves, but since Sailplane Corp. of America is one of the most experienced designers of wooden aircraft left in the U.S., this job was assigned to the contractor.

FRC issued the go-ahead order in October, 1962, and set 1/16-in. tolerances on the shell. It was delivered this month. The amount of the fixed price contract was less than $10,000.

Bikle has appointed a design inspection board to conduct a thorough critique of the engineering and construction of the carriage and shell. If the board finds flaws that might endanger validity of research or the life of the pilot, the necessary modifications will be made at the expense of schedules.

As a low-cost, advanced-technology program, *M-2* schedules have a low priority anyway. The requirements of the *X-15*, *X-20*, or any other high-

priority program can intervene at any time to delay *M-2* work.

Ames and Langley provide continuing support to the program. *M-2* shapes modified to include the fixed tricycle landing gear, cockpit canopy, and extra stabilizers and control surfaces of the FRC configuration have been tested in the Ames low-speed wind tunnel.

If tunnel availability permits, FRC plans to send the actual glider to Ames for tunnel tests to verify its similarity to the tunnel models previously tested. This could happen before actual flights, though present tunnel schedules make it unlikely. Small scale towed models were tested in the Langley free-flight wind tunnel.

• **Auto towing planned**—First flight tests will start with a series of automobile-towed flights from the dry lake at Edwards to progressively higher altitudes. If the *M-2* lifting body proves to be an unsafe aircraft or if test data seems invalid, the program will be halted, reviewed and perhaps abandoned.

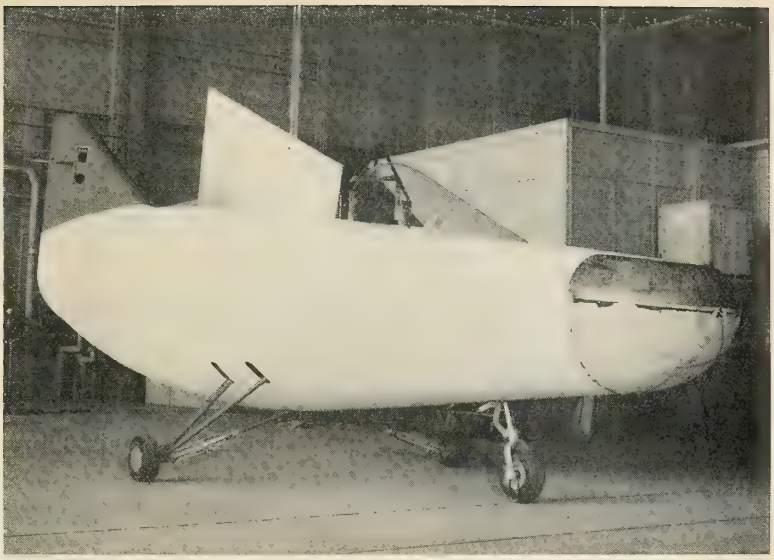
If auto-tow tests are successful, the program will proceed to flights in which the *M-2* is towed aloft by a light aircraft. The same sequence was flown in the *Paresev* program.

The "wing" loading of the *M-2* glider will be quite low initially to give a landing speed of about 60 mph. If the complete test sequence is successful, the craft's weight will be doubled by covering its external surfaces with fiberglass and adding instrumentation and ballast to increase landing speed by 50%. The test sequence will then be repeated at the new weight to see how the vehicle handles.

Should NASA headquarters become enthusiastic about this step-by-step progress, it would be possible to build and test a rocket-powered aluminum version of the most promising shape to determine flight characteristics in the transonic speed region. This would move the program out of the ultra-low-cost category, requiring more conventional program administration.

• **Boat shape**—The *M-2* is a flat-topped wooden-boat shape with elevons at the upper edge of a blunt aft end, and a pair of aluminum vertical fins fitted with rudders having blunt trailing edges like an actual hypersonic entry glider. Since little is known about the stability and control of these wingless lifting bodies, a removable third vertical stabilizer has been added on the centerline of the *M-2*, and extra elevons are mounted high and outboard on the two main fins. These can be removed or cut down if they are not needed.

The central fin and inboard elevons are of fabric-covered tubular aluminum. Because of the blunt aft end of the *M-2* lifting body, downward deflection of the elevons would not be very effective in producing a nose-down control force. The body is therefore designed to require an upward deflection of the elevons to maintain a constant attitude. Reduction of this deflection causes the aircraft to nose down; increasing it causes it to nose up.



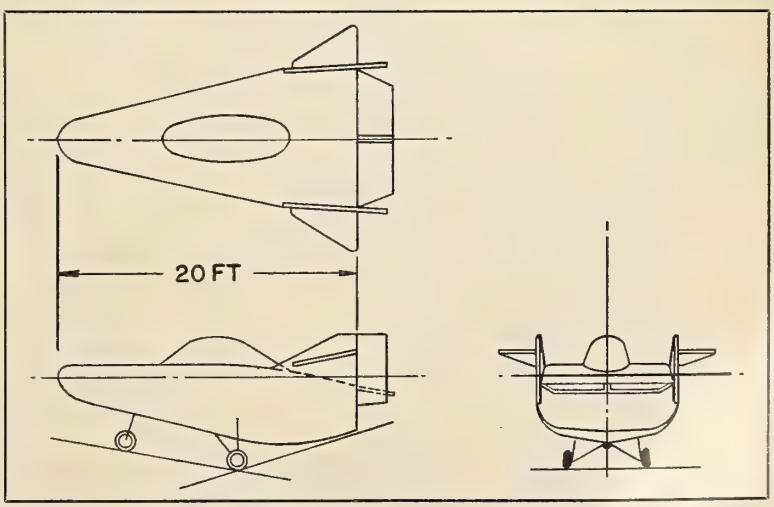
REMOVABLE CENTER fin on boat-shaped M-2 is to assure directional stability.

• **Weight, performance forecasts**—The maximum gross weight of the *M-2* glider is about 800 or 900 lbs. It was not designed to a strict weight budget since the exact total is important only for data-reduction purposes. The assembled vehicle will be weighed by FRC.

Performance calculations indicate that it should have a maximum lift-drag ratio of about 4.0:1 giving it maneuverability and landing characteristics much like the *X-15*, though at a much lower speed because of the lower wing loading. Its best glide slope angle should be about 15°. Increasing the weight will increase speeds and descent rates without significantly affecting the lift-drag ratio and glide angle.

A lightweight zero-zero ejection seat with a rocket catapult is being designed for the *M-2* glider under a 60-day contract for less than $5000 by Weber Aircraft Corp. It will not be used on early low-altitude auto-tow flights.

The seat will weigh 100 lbs. Installation will add only 70 lbs. to the gross weight of the glider after removal of the 30-lb. fixed seat. It is an offshoot of a program by Weber to develop a versatile lightweight ejection seat that can be purchased off the shelf at reasonable cost for one-of-a-kind applications. ❖

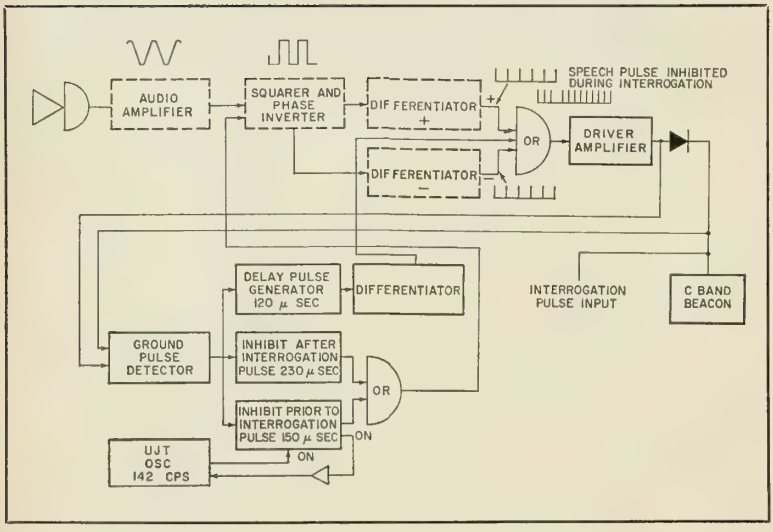


WIDTH of lifting-body glider is 9½ ft., not counting 27-in. long outboard elevons.

C-Band Link May Aid in Re-entry

Avco's 'Astrovoice' system operating on C-band radar tracking network could help solve blackout difficulty

by Michael Getler



ENCODER diagram shows (dotted lines) blocks required for speech processing.

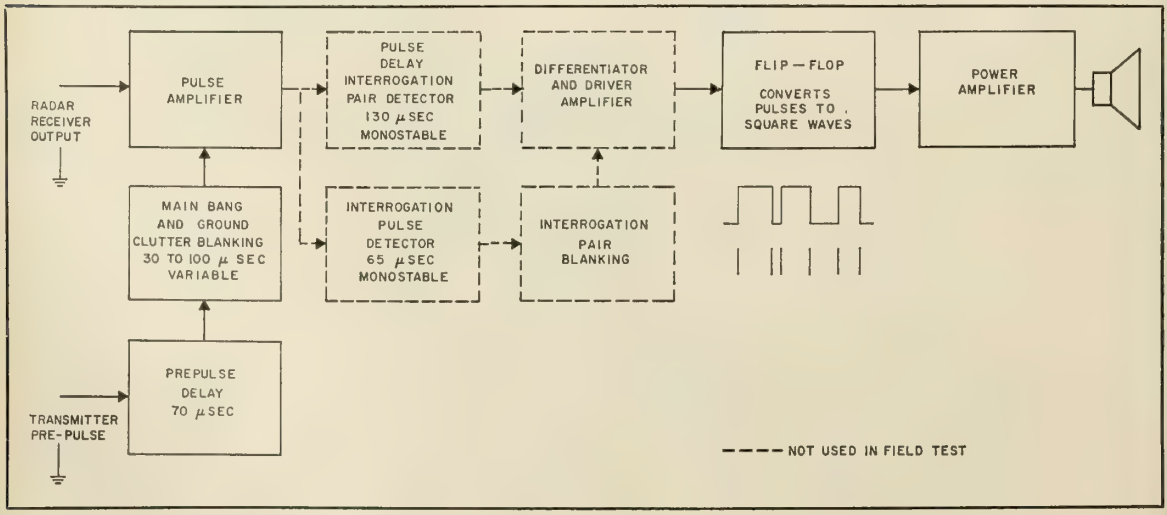
WILMINGTON, MASS.—Engineers at Avco Corp.'s Research and Advanced Development Div. here are developing a simple and lightweight C-band space communications voice link which may lead to solution of communications blackout problems during the atmospheric re-entry phase of manned spaceflight.

The firm was recently awarded a $60,000 NASA contract in support of its work.

Avco began developing the system, called Astrovoice, soon after the first manned orbital *Mercury* launching last February, when it became apparent that while the VHF voice link was blacked out by the plasma sheath generated during re-entry, the C-band tracking radars were still able to perform.

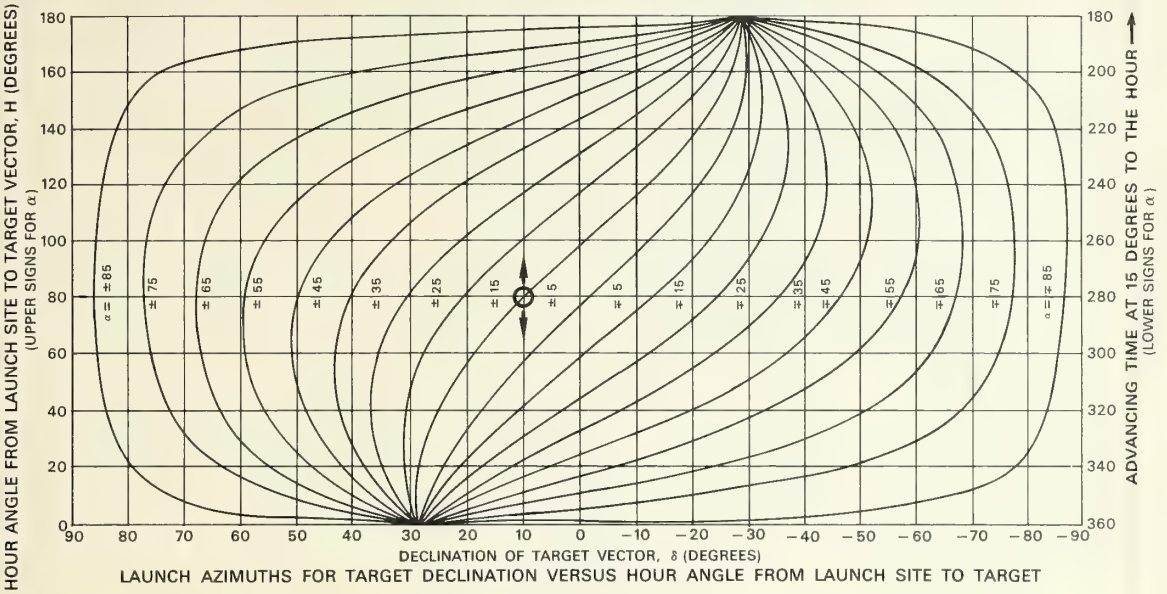
The Avco system involves adding a voice channel to the already available C-band tracking radar link — with a

(Continued on page 33)



DECODER DIAGRAM shows (solid lines) blocks required for demodulation.

LUNAR LAUNCH · JULY 17, 1968



LAUNCH AZIMUTHS FOR TARGET DECLINATION VERSUS HOUR ANGLE FROM LAUNCH SITE TO TARGET

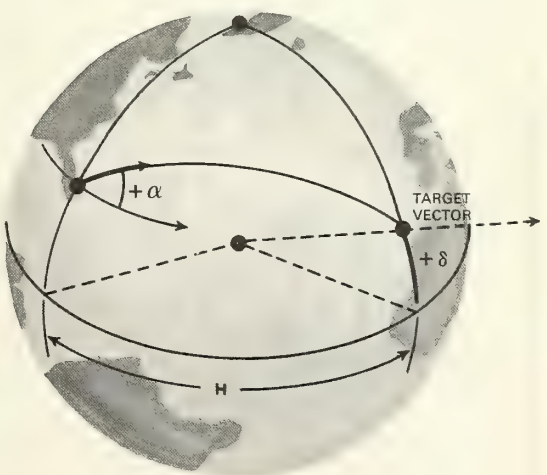
How do you launch into a geocentric planar trajectory from Cape Canaveral to a specified target vector? This family of curves demonstrates the interrelationships of the target vector declination, equatorial hour angle and launch azimuth. They can be used to estimate the launch requirements of lunar probes. For example, suppose a lunar vehicle launch is scheduled for July 17, 1968. At this time the declination of the moon will be $+10°$ (NASA Technical Note D-911). Assuming an hour angle of $80°$, the launch azimuth can be found to be $+5°$. The azimuth change for a ± 1 hr. launch window ($\pm 15°$ in H) will be $\alpha = -2°$ to $+12°$ as can be determined by moving along the $\delta = 10°$ line.

ENGINEERS:

Plotting complex launches to the moon and planets is among scores of space-oriented activities in progress at Astronautics. We're also deeply involved with the development and design of boosters and vehicles for space exploration and travel. We're developing, too, the incredibly precise electronic systems necessary to guide and track and communicate with these probes.

Our constantly expanding efforts have created a number of outstanding positions for engineers with exceptional ability. If your interests and experience qualify you—if you'd like to work mind-to-mind with the top technical talent of the space age—we urge your immediate inquiry.

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics| Astronautics, 5813 Kearny Villa Rd., San Diego 12, California.

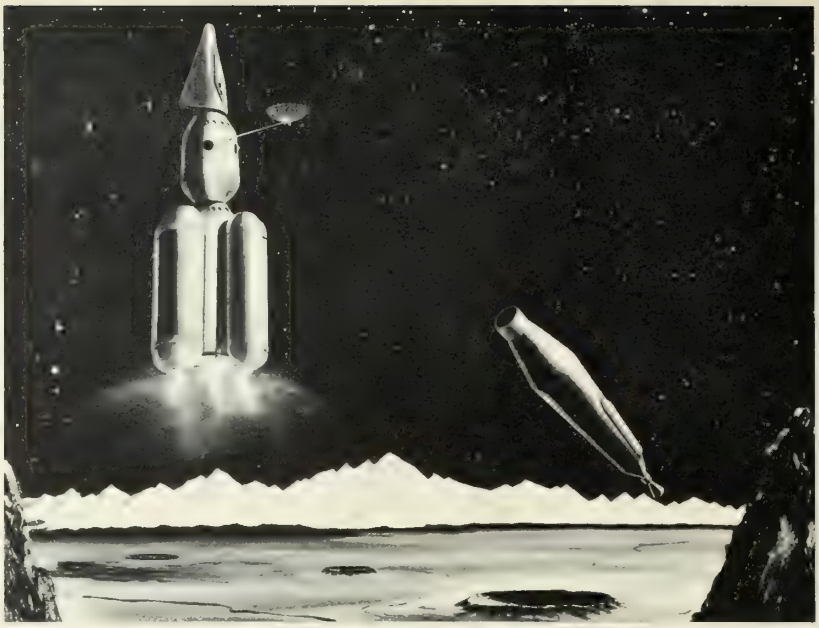


GD

GENERAL DYNAMICS | ASTRONAUTICS

AN EQUAL OPPORTUNITY EMPLOYER

LUNAR LANDING This spacecraft conceived by General Dynamics | Astronautics is shown backing down onto the lunar surface, controlled by powerful retro-rockets, after its journey from the earth. The discarded second-stage fuel tank is shown at right. Large tanks, clustered at base of the capsule and clamshell re-entry glider vehicle, provide fuel for landing on the moon and take-off power for return to earth. The tanks also provide a measure of protection against space radiation for the crew. Rockets are arranged at slight angles to the craft to avoid problems in landing which might be caused by "digging" holes in the surface of the moon.



DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamic behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

AERO-THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

MECHANICAL DESIGN

Mechanical Engineers with design experience in structures or pneumatic and hydraulic systems, are required for weapons and space systems design. Experience in design for extreme environmental conditions or for cryogenic fluids including liquid hydrogen is highly desirable. BS in AE, ME, or CE required.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

GUIDANCE AND TRAJECTORY ANALYSIS

Analytically talented graduate engineers, physicists, and mathematicians at all levels are required to participate in the support of existing guidance systems and the development of advanced guidance techniques. Minimum of two years of appropriate experience is preferred. Positions exist in the following areas:

SPACE BOOSTER AND WEAPONS SYSTEMS GUIDANCE ANALYSIS: to provide guidance support for programs covering a broad spectrum of ballistic weapons systems and space booster endeavors. Formulation of guidance equations, evaluation of new deployment methods, and the development of future guidance techniques are carried out. Guidance systems presently under consideration include radio-inertial, pure inertial, stellar-inertial, no gimbal inertial, terminal and homing. Positions involve wide application of digital computers in the simulation and analysis of trajectories, real time guidance computations, and performance of booster and payload systems and subsystems.

GUIDANCE SYSTEMS RESEARCH: to develop techniques, equations, simulations and trajectories necessary to perform launch, satellite rendezvous, lunar landing, re-entry and return to prescribed earth sites. Both automatic and manual guidance systems are being investigated using analog and/or digital simulation techniques. The methods of optimal control theory and statistical filtering are being developed and applied to trajectory determination and control. The characteristics of lunar and interplanetary trajectories, including the interrelation of such parameters as velocity requirements, launch windows, time of flight, and inclination angles, are being investigated.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

Graduate engineers will also find long-range opportunities in the following specialties: STRUCTURAL DESIGN, RELIABILITY, OPERATIONS AND SYSTEMS ANALYSIS, ELECTRONIC DESIGN AND DEVELOPMENT, WELDING ENGINEERING, WEIGHTS ENGINEERING, TECHNICAL WRITING AND COMPUTER PROGRAMMING.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5813 Kearny Villa Road, San Diego 12, California.

GD

GENERAL DYNAMICS | ASTRONAUTICS

AN EQUAL OPPORTUNITY EMPLOYER

Avco's 'Astrovoice'

(Continued from page 28)



RELATIVE SIZE of spaceborne encoder is apparent here. Device is all solid-state, weighs less than one pound, needs less than one watt input power.

minimum of spaceborne equipment and only slight modification to the ground-based radar.

Using the existing C-band beacon and antenna system in the spacecraft, Avco proposes to add only a voice encoder to the in-flight equipment. The all-solid-state device reportedly occupies about 20 cu. in., weighs less than 1 lb., and requires less than 1 watt input power. At the ground receiving end is the RCA-developed FPS-16 monopulse tracking radar, modified with a decoder and interference inhibiting circuits. Avco reports RCA's more advanced FPQ-6 radar, which is now being phased into the NASA tracking network (M/R, July 23, p. 34), can also be easily modified and used.

• **Site studies**—Under terms of the recent NASA award, Avco will also investigate a wide variety of likely ground-based and shipboard sites where modification for Astrovoice may be feasible.

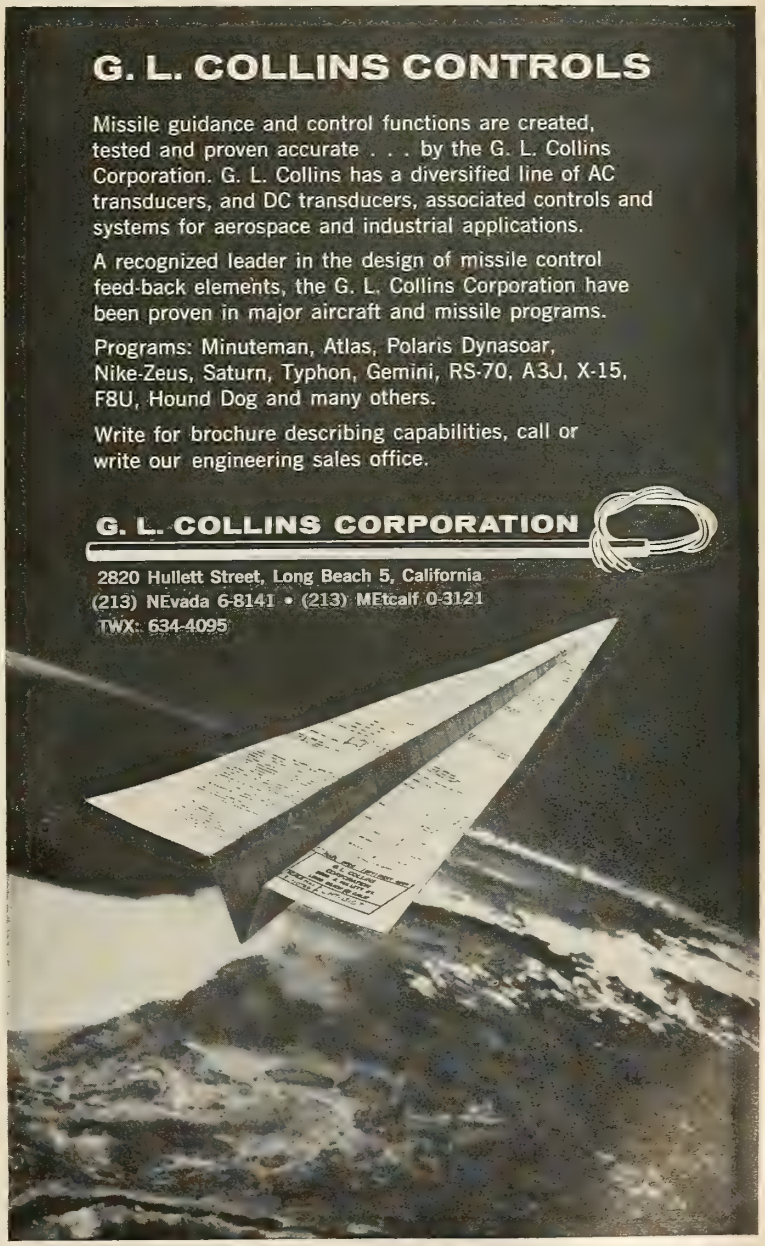
John J. Mahoney, assistant manager of Avco's Telemetry and Instrumentation Dept., says virtually no additional hardware is required for the FPS-16 modification, and the bulk of the new circuitry is needed to inhibit voice interference with the acquisition and tracking functions. The decoder, he reports, can actually be made even smaller than the spacecraft encoder.

The basic modification requires drawing 28-volt power for less than 1 watt from the radar for decoder operation, and extracting the decoder's video input from the integrated video channel. Also, Mahoney notes, a synchronized pre-pulse is extracted from the radar and used to generate a blanking gate in the decoder to inhibit feedthrough of the transmitted pulse into the receiver. The three decoder inputs (power, video, pre-pulse signal) yield a single audio output that feeds directly into the FPS-16 communications subsystem.

The current Avco design calls for development only of a space-to-ground communications capability with this equipment.

Soon after the successful *MA-6* flight, Avco made a presentation to NASA of the breadboarded C-band encoder and decoder operating with the existing C-band beacon, made by ACF Electronics Div., and antenna, made by Melpar, Inc. Demonstration that presence of voice on the tracking link was not harmful moved the space agency to fund a round of experimental flight tests last May, using aircraft assigned to the *Mercury* program as the airborne test vehicles and FPS-16 units at Eglin AFB, Fla.

• **Feasibility shown**—High ambient noise levels within the aircraft cockpit made live voice transmissions difficult during the first series of tests. However, Avco reports, when taped messages



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TITAN III

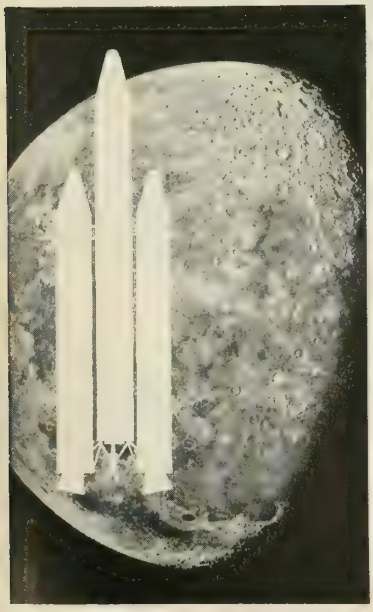
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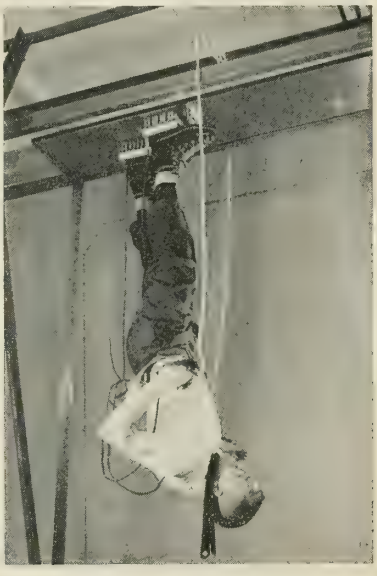
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(considered more realistic in reflection of spacecraft cabin noise levels) were fed into encoders, the acquisition, track, and voice transmissions were successfully handled on the single link.

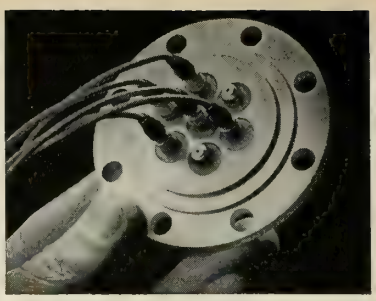
The recent NASA contract with Avco is for an eight-month study aimed primarily at producing refined demonstration equipment. Astrovoice use in the remaining *Mercury* launching is not planned, but the system may be tested during the *Gemini* program, though re-entry parameters will be somewhat different from those encountered with the *Mercury* recovery. There is also a possibility, not now being developed extensively, that telemetry could also be added to the single C-band link without undue degradation.

The refinements which Avco is making to improve Astrovoice performance basically involve removal of any degrading effect the tracking pulse has on the voice link, and, in general, making further reductions in system noise. Mahoney reports that the presence of the tracking pulse, which created a cyclic phase reversal of the audio waveform, has been sidestepped by generating a restoration pulse within the spacecraft encoder with roughly a 100-microsec. separation between the two. This change, however, created an audible hum on the link; this reportedly has also been eliminated through a delay circuit in the decoder equipment. ⁂



Which Way is Up?

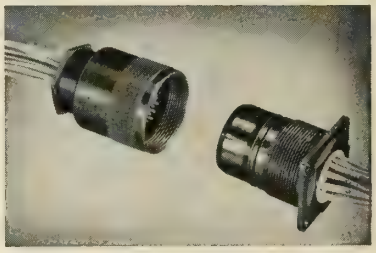
TECHNICIAN wears space shoes that use a permanent magnet with characteristics of an electromagnet. Circuit can be turned on or off; remembers its on/off condition indefinitely. Transfer of flux in Westinghouse Electric Corp.-developed magnet can be mechanical or electrical.



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Zierdt Says Propellants Cost Too Much

Pershing first stage, Nike-Hercules sustainer cited as examples by Materiel Command general

by John F. Judge

PHILADELPHIA—Propulsion costs for Army tactical missiles are too high, says Brig. Gen. J. G. Zierdt, Army Materiel Command.

Zierdt told the American Rocket Society's recent Solid Propellant Conference here that the first stage of the *Pershing* missile costs an estimated $43,000 for the motor alone. The motor consists of a lightweight steel case, nozzle, igniter and about 4500 lbs. of propellant.

Especially difficult to understand, says Zierdt, is the fact that the propellant is produced in a modern, automated plant, and the inert components are "supposed to be manufactured by the latest, low-cost mass-production techniques."

Another example of high costs he cited was the *Nike-Hercules* sustainer motor. Even after thousands of units, says Zierdt, the motor costs more than $6400 and contains a little over 2100 lbs. of propellant.

Zierdt qualified his remarks by admitting much of these costs result from inspection, reliability, quality control and destructive static tests, but still insisted the propulsion area should be scrutinized.

• **Alternatives to solids**—The Army is not necessarily commited to solid propellant technology, says Zierdt, since prepackaged, storable liquids might be the answer for a high-performance delivery system. Hybrids also hold high promise for providing a throttled engine along with the kind of end-item performance the Army needs.

Other Army requirements covered include the problem of providing artillery fires over a wide span of ranges. Conventional tubed weapons are too heavy and cannot meet the longer range needs.

While military rockets have a distinct advantage in range and logistics, they become too complex and expensive in achieving the desired pinpoint accuracy. "You can't fire very many" says Zierdt, "when the stabilized platform alone costs over $100,000 per round."

Defeating enemy armor is still a major problem. While Zierdt claims the Army can handle any tank known today, there is a need for a weapon capable of keeping enemy tanks off the battlefield in future conflicts.

Current antitank weapons are effective, but again, they cost too much and experience has shown a first-round hit is essential. Zierdt suggests a simple, short-burning-time rocket delivering either a shaped charge or a kinetic-energy warhead to the target with a flat trajectory at high velocity and accuracy. The round could use an optical sighting system to avoid complex fire-control equipment.

Zierdt pointed to the charge-to-mass ratio on small diameter rounds as being quite poor relative to the *Zeus* motor. Nor could he see any reason why gas-injection thrust-vector-control could not be applied to small Army rockets. Selectable impulse control was suggested as a method of zoning artillery rockets.

• **Flight time a problem**—Missile defensive weapon problems were outlined briefly by the general. The one major headache is reducing the flight time. This means extremely high acceleration—about 100 g's—with fast burning compositions. Zierdt says the Army is willing to relax environmental requirements if there is "good" payoff in performance.

Because the sustainer sometimes accompanies the warhead, sophisticated design is essential for minimum weight. Blast tubes, for example, create insulation problems, and need to be eliminated. Radar attenuation by exhaust gases may be troublesome for command-guided weapons.

In other areas, the use of programmed thrust to combine as many functions as possible in a single motor is worth more effort, says Zierdt—especially in low-altitude, shoulder-fired weapons such as the *Redeye*.

Zierdt listed five specific solid propellant characteristics and the desired improvements:

—Higher specific impulse accompanied by reasonably high density.

—A wider range of burning rates to permit more flexibility in motor design.

—Temperature coefficients that provide ballistic uniformity over wider ranges of climate conditions.

—Better physical properties to withstand the Army's rough handling.

—Propellants storable for years without significant changes in properties.

• **Above average meeting**—Most attendees generally agreed on the high quality of the papers presented. Those talks directed toward specific weapon systems were classified. Unclassified sessions covered reliability and safety.

Some programmed session critics made the going rough for participants caught with hastily prepared papers or those lacking in information. The conference was a decided improvement over past solid meetings, with many of those present giving the credit to the chairman, John B. Gustavson.

In one paper, Alcoa experts H. J. Morales and E. H. Spuhler presented the case for the on-site fabrication of large aluminum motor containers. Four aluminum alloys, three general fabricating methods and two end-closure joining processes were covered. The four alloys were 7178, 2219 and an X7006-type.

The Alcoa engineers adhered to the following design considerations and assumptions:

—Solid rocket motors will be about 22 ft. in diameter and at least 100 ft. long.

—All manufacturing processes and techniques should be in present use.

—In addition to satisfactory performance, low cost and high strength-to-weight ratios were also crucial factors.

The three methods of fabricating the huge sidewall cylinders included:

—Joining of roll-formed, high-strength plate longitudinally into cylindrical sections, and then joining these circumferentially to reach the desired length.

—Casting of a continuous sidewall to the total required length, using a method currently employed to produce cylinders 3 ft. across and 10 ft. deep.

—"Roll-extruding" of cylindrical sections up to 20 ft. long in the desired diameter and joining these circumferentially to arrive at the final length.

• **Roll-extrusion coming**—This final method, roll extrusion, was developed

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by N.T.W. Missile Engineering, Inc., Los Angeles. The firm recently received an Air Force contract to design and build a machine capable of producing parts 100 to 160 in. in diameter and up to 20 ft. long. This equipment is scheduled for operation by December 1963.

A much larger machine would have to be built on-site to handle the massive 260-in. and larger units. The process displaces metal by compression between a die ring and internal work rollers. The die ring and workpiece rotate and, as the metal is pulled through the ring, the workpiece elongates in proportion to the reduction in thickness produced by the pressure of the rollers.

All three fabricating methods would necessitate heat-treating or aging equipment at the site.

End closure forming would use one of two possible methods. The first would involve joining of gore sections to make a hemisphere, which would then be explosive-sized to final dimensions. Gore sections could be made at existing facilities, but the explosive-forming facility would have to be built at the on-site location.

The second method takes advantage of a unique characteristic of the 2219 alloy. It entails butt-welding flat plate sections to form a plate large enough for spinning. This plate would be solution heat-treated and quenched after welding. The spinning operation would impart a small amount of cold work, and the dome would then be aged at temperature to attain T81 properties.

The Alcoa engineers cite cost, processing and temperature-treating limits as advantages in the use of aluminum over other metals contemplated for the big cases. Performance factors of the aluminum alloys compare favorably with current metallic materials, say the authors.

Other papers covered internal reinforcement of propellant grains, safety in all of the myriad operations in solids, procedures in demonstrating the reliability of large solids where full scale firings are obviously expense-limited, and an approach to analyzing secondary thrust vector control.

Aerojet-General exhibited its 280-in. motor case at the meeting. The handling case (M/R, Jan. 28, p. 28) was fabricated by Sun Shipbuilding and Drydock Co., a subsidiary of the Sun Oil Co.

• **Big solid potential**—Thomas F. Dixon, NASA deputy associate administrator, covered the DOD/NASA large solids program (M/R, Feb. 4, p. 14) emphasizing the nozzle problems on 260-in. solid motors.

The throat diameter for such a solid would run to 91 in. or more—considerably beyond the current production size of graphite blocks. Such nozzles, he said, might use laminated materials or graphite building blocks to circumvent the size problem.

Dixon said the approved program will ignore fluid injection systems in thrust vector control, since these are well established. The major effort will go into movable nozzle systems—gimballed or swivelled. System studies conducted by Boeing and Martin for NASA have indicated such an approach will be attractive from many viewpoints if movable nozzles prove as reliable as they have in the past.

Both movable and jet-tab systems will be checked out on the planned segmented 156-in. motors.

Dixon said it seems likely that reliance will be placed on solid systems as NASA moves deeper into space for the same reasons now used by the military—reliability, storability, ruggedness, low development costs and instant readiness.

Dixon gave a general rundown of NASA's work in solids, but cautioned against anticipating any build-up in this area at the expense of the heavy demands now imposed by the lunar landing program. He then admitted that the general viewpoint of all those concerned with propulsion has shifted in regard to the use of solid rocket engines for space purposes—with some experts considering them the answer to many big booster requirements. ⌗

The Industry Week

Insurers Invest in Missile/Space

Life insurance company investments—direct and indirect— in missile/space firms total about $5 billion, the Institute of Life Insurance indicates. About one-third of these funds are invested in firms that are mainly or entirely concerned with missile/space activities, the institute said, and the remainder is invested in widely diversified firms that include aerospace activities among their many functions.

According to a spokesman for the institute, the funds are used primarily in the following ways: direct loans; mortgages; transactions in which life insurance companies purchase facilities and then lease them back to manufacturers; purchase of some bonds; and a small amount in common stocks.

Here are some of the firms in which insurance companies are investing, according to ILI records: Boeing, $23 million; Douglas, $28 million; Aerojet-General, $12 million; Ling-Temco-Vought, $8 million; Lockheed, $34 million; Martin Marietta, $67 million; Ryan, $5 million; United Aircraft, $69 million; General Dynamics, $142 million; North American Aviation, $4 million; Avco, $17 million; Lear Siegler, $3 million; Texas Instruments, $12 million; Litton Industries, $4 million; Raytheon, $40 million; Sperry Rand, $107 million; Thompson Ramo Woolridge, $14 million.

Also: Motorola, $25 million; Sylvania, $44 million; Perkin Elmer $4 million; Hooker Chemical, $30 million; General Precision, $36 million; General Instruments, $12 million; IBM, $495 million; AT&T, $1.019 billion; IT&T, $15 million; Westinghouse, $168 million; GE, $63 million; RCA, $245 million; Chrysler Corp., $252 million; Burroughs, $12 million; Minneapolis-Honeywell, $13 million; Ford Motor Co., $140 million; Union Carbide, $378 million; Borg Warner, $15 million; and General Motors, $147 million.

Industry Facilities

Construction begins this week at Canoga Park, Calif., on a new four-story building to house executive offices and division headquarters for North American Aviation, Inc.'s Rocketdyne Div. The third building under construction at Rocketdyne's Canoga Park complex, it will cost more than $1 million to build. . . . *In a move to double its production capability in welded structural shapes and to increase its service to customers in the West, Kaiser Steel Corp. has bought the former Graver Tank & Welding Co. at Fontana, Calif., and is refurbishing the facility and installing new equipment there. The conversion at the 11-acre plant, adjacent to the Kaiser mill, will cost over $1.* . . . Philco Corp. is working rapidly to staff the Mission Control Center it will establish for NASA 20 miles from Houston. The firm's Western Development Laboratories was named by the space agency to establish the center, though the final contract has yet to be negotiated. The center will direct *Gemini* rendezvous and *Apollo* missions. A spokesman estimated that by this week "a team of 200 electronics and space system experts will be on the job" at the center, and that full staff is expected to reach 350-400 scientists and technicians. . . . *Angstrohm Precision Inc., developer-manufacturer of resistance test instruments and advanced resistive components in the precision film and wire fields, has moved to new quarters in Hollywood, Calif. Including clean rooms, temperature control laboratories and manufacturing area, the new facility represents a five-fold expansion of the firm's previous facility and allows for twice the working area. API was founded less than a year ago.* . . . H. K. Porter Co.'s Alloy Metal Div. has opened a new district sales office at Riverside, N. J., five miles from Philadelphia. The office will serve Delaware, Maryland, Virginia, the District of Columbia and parts of New Jersey and Pennsylvania. . . . *United Aircraft Corp.'s United Technology Center has set up a base at Cape Canaveral for flight-testing its solid-propellant first-stage rockets for Titan III. A staff of 150 engineers, technicians and administration personnel eventually will be assigned to the base for testing the 120-in.-dia. segmented motors.* . . . The Bell Aerosystems Co. division of Textron's Bell Aerospace Corp. will spend $1.4 million on a major addition to the administration building at its Buffalo (Wheatfield Township), N.Y., plant. Construction is under way on the two-story, 75,000-sq.-ft. addition, to be ready for occupancy in August. . . . *A $3.5-million device reportedly capable of simulating virtually any flight by any manned spacecraft will be constructed and installed soon at the Aerospace Research Pilot School at Edwards AFB, Calif. The contractor, General Precision, Inc.'s Link Div., expects to complete the installation by June, 1964. Major feature of the simulator is a pilot-computor closed-loop system that will continuously inform the pilot of the consequences of his control actions. Designed to simulate re-entry as well as space flight, the device may be used by NASA for astronaut training programs.*

All Datacom Terminals Active

The Andrews AFB, Md., terminal of the Air Force Automatic Digital Network (Datacom) was activated last week, bringing near to completion a four-year program of development and installation for the world's largest and most advanced digital communications network.

This is the fifth and last of the terminals to be activated.

Datacom will link 300 Air Force, Army, Navy, DOD and industry tributary stations into a common system for rapid interchange of information. It is leased from Western Union—the prime contractor—and operated by the Air Force Communications Service. Radio Corp. of America produced the switching gear and tape terminals; International Business Machines Corp. furnished out-station compound terminals.

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AWARDS

AIR FORCE

$29,350,600—**Boeing Co.,** Seattle, for continued research and development on *Minuteman* missiles at Seattle and at Patrick AFB, Fla.

$14,716,533—**Boeing Co.,** Seattle, for *Minuteman* work (2 contracts).

$10,909,000—**Boeing Co.,** Seattle, for work on the *Minuteman* weapon system. Work to be done at Vandenberg AFB, Calif., and at Seattle.

$10,000,000—**Boeing Co.,** Seattle, for fixed assembly and checkout of equipment for *Minuteman* sites at Ellsworth AFB, S.D.

$8,702,096—**Western Electric Co.,** New York City, for SAGE system management services.

$6,643,000—**Aerojet-General Corp.,** Azusa, Calif., for *Titan II* propulsion work, to be done at Sacramento.

$6,000,000—**Martin Marietta Corp.,** Baltimore, for research and development on manned launch vehicle for the *Gemini* program.

$5,920,360—**Ryan Aeronautical Corp.,** San Diego, Calif., for the production of aerial target drones.

$5,920,307—**General Dynamics Corp.,** New York City, for work on space programs (3 contracts). Work to be done at San Diego and Lompoc, Calif.

$4,000,000—**General Electric Co.,** New York City, for work on the *Titan II* program (supplemental contract).

$3,550,247—**General Precision, Inc.,** Little Falls, N.J., for missile guidance equipment.

$3,155,000—**Systems Development Corp.,** Santa Monica, Calif., for development and preparation of system training programs.

$3,150,000—**Martin Marietta Corp.,** Baltimore, for continued research and development on *Titan II*. Work to be done at Littleton, Ohio.

$2,886,450—**Bendix Corp.,** Detroit, for research and development for communications systems for SAC. Work to be done at Ann Arbor, Mich.

$2,532,514—**General Cable Corp.,** New York City, for *Minuteman* cable installations. Work to be done at Minot AFB, N.D.

$2,514,000—**Martin Marietta Corp.,** Baltimore, for installation and checkout of *Titan I* missile facilities. Work to be done at Ellsworth AFB, S.D.

$2,241,000—**Western Electric Co.,** New York City, for an improved ultrahigh-frequency air-ground communications system.

$2,200,000—**Lockheed Aircraft Corp.,** Burbank, for space work, to be done at Sunnyvale, Calif.

$2,160,528—**Aerojet-General Corp.,** Azusa, Calif., for solid-fuel rocket motor work at Sacramento, Calif.

$2,000,000—**Aerojet-General Corp.,** Azusa, Calif., for development and fabrication of *Titan II* propulsion system for *Gemini* program. Work to be done at Sacramento, Calif.

$1,822,500—**Douglas Aircraft Co., Inc.,** Santa Monica, for rocket launch services at Vandenberg AFB, Calif.

$1,674,617—**Olin Matheison Chemical Corp.,** New York City, for anhydrous hydrazine for use in the *Titan II* program. Work to be done at Saltville, Va.

$1,615,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for provision of a launch-service capability for the Pacific Missile Range.

$1,500,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for work on the design, development and production of electronic security systems to aid the *Minuteman* missile program.

$1,415,000—**Burroughs Corp.,** Detroit, Mich., for computer services, range safety and instrumentation in support of space programs at Patrick AFB, Fla.

$1,200,384—**Sundstrand Corp.,** Rockford, Ill., for research on solar dynamic power conversion.

$1,062,500—**Reflectone Electronics, Inc.,** Stamford, Conn., for electronic equipment.

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$500,000—**Geophysics Corp.,** Bedford, Mass., for a study of new optical techniques to identify decoy missile warheads fired against the U.S.

Lear Siegler, Inc., Instrument Div., Grand Rapids, Mich., for cockpit instrument research and development for rocket-powered manned vehicles (undisclosed amount).

ARMY

$4,150,000—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for continued development of the *Shillelagh* missile system.

$2,700,000—**Melpar, Inc.,** Falls Church, Va., for continuation of research and development of chemical agent detection and warning devices.

$1,785,000—**Sperry Rand Corp.,** Salt Lake City, for *Sergeant* missile equipment.

$1,755,000—**Texas Instruments, Inc.,** Dallas, for classified electronic equipment.

$1,100,000—**Raytheon Corp.,** Bedford, Mass., for classified work.

$993,871—**The Ross Corp.,** New Orleans, for construction of a rocket test cell.

NAVY

$3,000,000—**Minneapolis-Honeywell Regulator Co., Aeronautical Div.,** Minneapolis, for production of inertial guidance platforms for the *Polaris* missile Mark II guidance system.

$1,989,384—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, for *ASROC* missile parts. Work to be done at Hopkins, Minn.

$1,500,000—**American Bosch Arma Corp., Tele-Dynamics Div.,** Philadelphia, for development and production of shipboard fire-control switchboard to coordinate information from radar and tracking devices on destroyers.

$1,458,173—**Altman-Coady Co.,** for construction of Inertial Guidance Maintenance Facility at Newark AF Station, Ohio.

$1,292,850—**Raytheon Co.,** Waltham, Mass., for *Polaris* missile fire-control equipment.

$1,125,321—**Minnesota Mining and Manufacturing Co.,** St. Paul, for rocket fuel research.

NASA

$299,561—**Martin Marietta Corp., Space Systems Div.,** Baltimore, for lunar mission simulation study program.

$255,970—**Hamilton Standard Div., United Aircraft Corp.,** Windsor Locks, Conn., for fabrication and testing of space suits and associated life-support systems.

$136,640—**Republic Aviation Corp.,** Farmingdale, N.Y., for a study of over-all systems requirements for a Synchronous Meteorological Satellite (SMS).

$118,500—**General Dynamics Corp.,** Fort Worth, Tex., for personnel dosimeter prototypes for *Apollo* command module.

INDUSTRY

$35,596,610—**Hercules Powder Co.,** Wilmington, Del., from **Lockheed Missiles and Space Co.,** for the production of second-stage motors for the *Polaris A-2* missile.

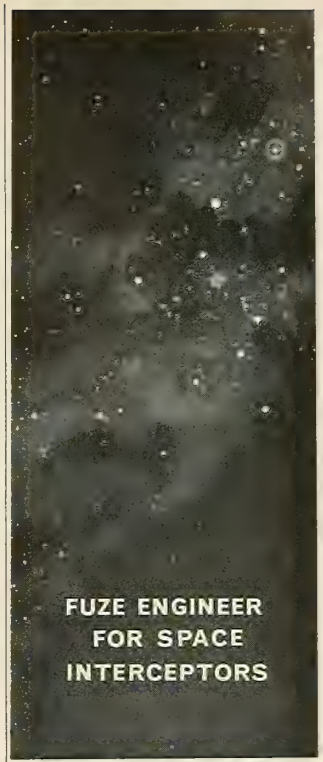
$10,500,000—**Ling-Temco-Vought, Inc.,** Dallas, from **North American Aviation's Autonetics Div.,** for the manufacture of actuators for the *Minuteman* missile.

$1,500,000—**Allis-Chalmers,** Milwaukee, from **Morrison-Knudson Co.,** for provision of 220 diesel engine-generator sets for the *Minuteman* missile complex being contructed around Warren AFB, Wyo.

$1,000,000—**Pneumodynamics Corp.,** Cleveland, from **Boeing Co.,** for shock absorbers to cushion *Minuteman* underground launch control centers.

$600,000—**Whittaker Controls and Guidance Div. of Telecomputing Corp.,** Los Angeles, from **Sandia Corp.,** for production of miniature attitude reference systems (MARS).

$162,000—**Cosmodyne Corp.,** Hawthorne, Calif., from **Boeing Co.,** for design, development and manufacture of hydrogen pumping units for the *X-20 (Dyna-Soar)* space glider.



An expert in unconventional applications and techniques is offered an exceptional opportunity to conduct fuzing studies for space interceptors in Hughes Advanced Projects Laboratory.

While fuzing experience would be helpful, it is not mandatory. Broad general background knowledge and high interest in the subject *is* required.

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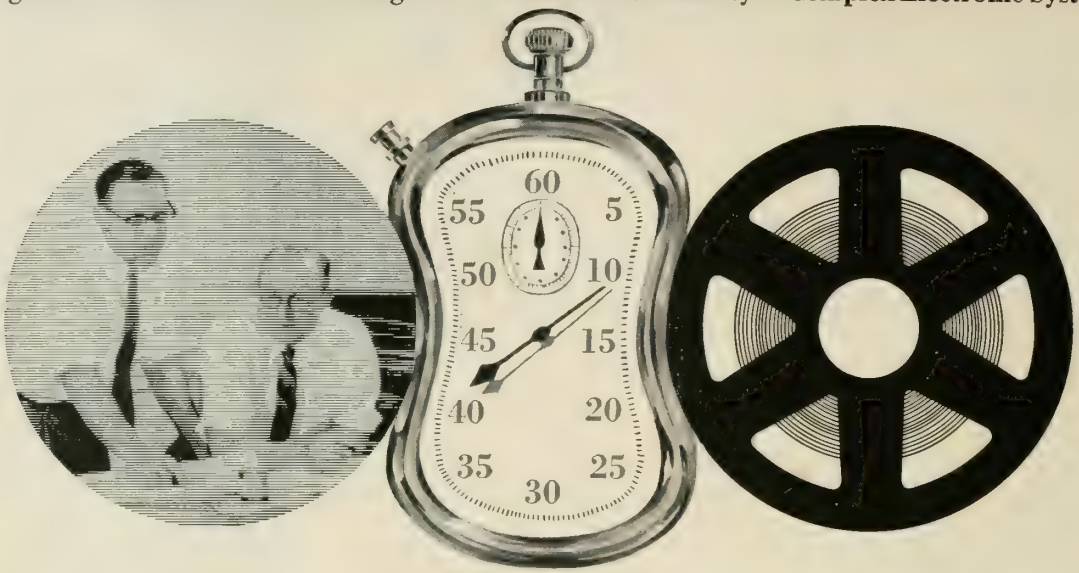
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THERMAL SYSTEMS ENGINEER
Heat transfer and systems analysis on missile and space vehicle structures and skins. Familiarity with thermal effects on electronic or guidance and control equipment desirable.

SPACE ENVIRONMENT/POWER SOURCE – ENGINEERS
Specialists to analyze vehicle compartment environments and design state-of-the-art air conditioning and power systems. A) experience in vacuum – acoustics or B) experience in solar energy, battery, thermo, nuclear, electrostatic space power sources.

ELECTRO-OPTICAL SYSTEMS ENGINEERS
Evolve and specify systems such as star sensors, horizon scanners, and solar sensors. Prefer E. E. familiar with IR sensors and associated circuit techniques. Optical systems background desired.

SYSTEMS ANALYSIS AND SYNTHESIS – SR. STAFF ANALYSTS
Analytical work in areas of feedback control and inertial guidance systems at concept stage where guidance equations, systems evaluation and dynamic performance of guidance steering loops are to be studied.

MISSILE FLIGHT CONTROL ENGINEERS – ADAPTIVE/OPTIMAL
Original analysis and systems design of unique systems for missile and space vehicles. Will work closely with inertial guidance systems engineers to tie in flight control; integrate equipment for associate and subcontractors and insure operational reliability.

INERTIAL GUIDANCE SYSTEMS – PROJECT MANAGERS
Comprehensive knowledge of inertial or hybrid-inertial systems to determine optimum systems parameters and configurations, specify and integrate stable platform, gyros, star trackers, and computer sub-systems into state-of-the-art stellar-inertial guidance systems for a mobile ballistic missile.

DIGITAL SYSTEMS ENGINEERS – MANAGERS & ENGINEERS
Analyze systems requirements and prepare specifications to sub-contractors for air/space-borne computers of state-of-the-art nature.

SUB-SYSTEMS SPECIFICATIONS – TECHNICAL LEADER
Analyze systems requirements and prepare spec packages for distribution to associate and sub-contractors.

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A newly formed Branch of our Aerospace Systems Division is being staffed at senior levels and requires talented technical and managerial candidates who will be concerned with our product line of the future. Areas now requiring additional key engineers are: Advanced Systems R&D – Aerothermodynamics – Electronics and Communications – Astro-dynamics – Structures and Materials – Astro/Aerospace Physics – Applied Math and Computing – Reliability – Human Factors – Advanced Systems Requirements and Development – Guidance, Computer, Control and Radiation Systems Engineering – Systems Integration – Mechanical Systems.

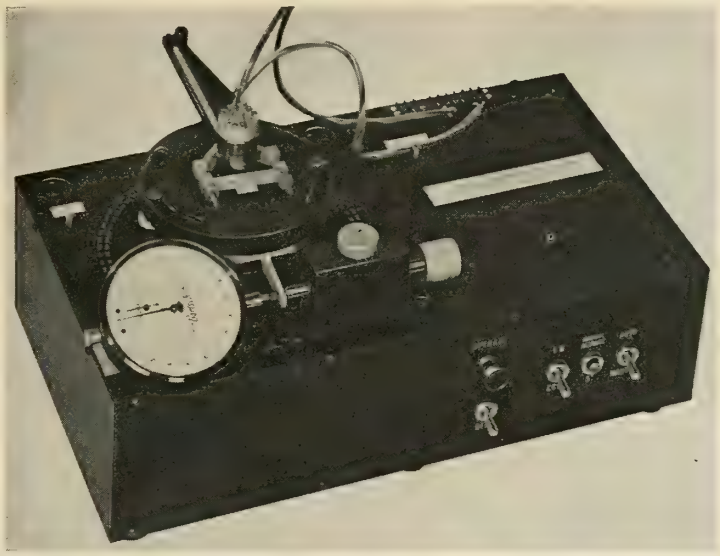
Write in professional confidence to Mr. Paul Kull

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New Product of the Week:

Automatic Dividing Head

A dividing head designed for both automatic and semi-automatic operation, with an accuracy of 10 seconds-of-arc, is available from Gertsch Products, Inc. The instrument permits angular measurements on all types of rotating components.

A front-panel toggle switch transfers operation from one mode to another. In the automatic mode, the head advances 5° every six seconds, pausing four seconds at each step. A 360° cycle is completed in 7.2 min. In semi-automatic operation, the head advances 5° with each actuation of a push-button switch. Rotation can be in either direction, selectable by a toggle switch.

Designated Model DH-8-M, the instrument features a universal holding arm that accommodates any size component from ½-in. to 1½-in. dia. Components are supported from their own shafts to prevent force errors, and to insure accurate measurements.

Circle No. 225 on Subscriber Service Card

Megohmmeter

A device designed to accurately measure high resistances of polarizable materials has been developed by the Telostat Corp.

This line voltage stabilized, completely transistorized unit reads directly, with no bridge balancing, a range of 0.1 to 10,000 megohms accurately and instantly. An external generator input allows applications to samples of frequencies other than 60 cycles. Low applied voltage and low impedance source and amplifier of the megohmmeter allows long leads to the sample. Provision is made for a recorder. Accuracy is ±10%.

The Model M2000 AC meghommeter can also be used as a high sensitivity a-c microameter or microvoltmeter, and is claimed to be ideally suited for use in the electrical or electronic industries for research or production control to measure megohms in humidity-sensitive elements, strain gauges, ionic conductors, insulators, semi-conducting materials, high impedance light or radiation sensitive elements and the like.

Circle No. 226 on Subscriber Service Card

Preamp Series

A preamplifier series for operation in five ranges from 0.55 to 10.75 gc is in production at Applied Technology, Inc. Development models have been operated successively in both fixed and transportable receiver systems for advanced reconnaissance applications. Each of the five rf, wideband 1° w-noise preamplifiers comprising ATI's UHA-



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He must have a personality which enables him to work easily and well with a variety of people—plus intellectual speed which permits him to react quickly to any situation. He must be inventive and imaginative, will probably hold several patents and will have had papers published in professional journals. His present position might be that of a preliminary design section head or staff head in an equipment design group.

If you feel that you qualify by training, experience and interest—and wish immediate consideration, please airmail your resume to:

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4/MWA-5 series includes an integral solid-state power supply for independent operation. The Type UHA-4, employing a cascade triode, operates in the 0.55-1.1 gc frequency range; MWA-5 types are available in four ranges: 1.0-2.6 gc, 4.3-7.4 gc, and 7.0-10.75 gc. The units are highly stable under temperature variations from −50° to 50°C and up to ±10% line voltage.

Circle No. 227 on Subscriber Service Card

Voltmeter

Ballantine Laboratories, Inc. is marketing Model 320A voltmeter that measures true RMS of a wide range of waveforms, including white noise, pulse, square wave or sinusoidal from 10 microvolts to 320v, 5 cps to Mc. three db bandwidth is 2 cps to 7 Mc. Logarithmic voltage scales of the instrument provide uniform accuracy over their entire five inch length. Model 320A can measure signals having crest factors five to 15, to 2% accuracy at mid-band



frequencies. It may also be used as a 90-db amplifier, 5 cps-4 Mc. D-c output is available for connection to a recorder.

Circle No. 228 on Subscriber Service Card

Frequency Synthesizer

A variable-frequency synthesizer providing precise frequencies from 50 cps to 50 mc in increments as small as 0.01 cps has been developed by Hewlett Packard Co.

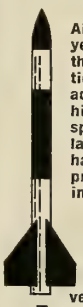
The Model 5100A, has 10 columns of pushbuttons arranged in standard decimal form for rapid frequency selection. Output frequencies may also be remotely programmed by contact closure. The range of frequencies represented by any one of 8 pushbutton columns can be smoothly varied either with the internal search oscillator or by applying an external voltage. The output

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TEST ENGINEER

Will plan and design test programs for rocket propulsion systems; prepare schedules and coordinate program to meet schedules; analyze test results and prepare test reports; design mechanical components for measurement systems; plan and coordinate environmental test program. BS or MS in ME or physics.

RADIOWAVE PROPAGATION ENGINEER

Will operate transmitters and field intensity measuring and reporting equipment and supervise technicians and non-skilled crew in site installations. Make decisions involving engineering judgment (measurement techniques and procedures) and perform limited field data analysis. BS in EE with experience in communications or field testing. Positions available in Washington, D. C., Arizona, and overseas.

ROCKET TEST SUPERVISOR

To work with Rocket Test Manager coordinating activities of instrumentation staff with other segments in the test group and throughout ARC. Responsibilities include design, selection, modification, and operation of instrument components and systems used in static testing of propulsion units. BS or MS in EE or physics and several years' experience.

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frequency voltage is 1 volt ±2 db from 50 cps to 100 kc, and 1 volt ±1 db from kc to 50 mc (into a 50-ohm resistive load).

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Telemetry Receiving System

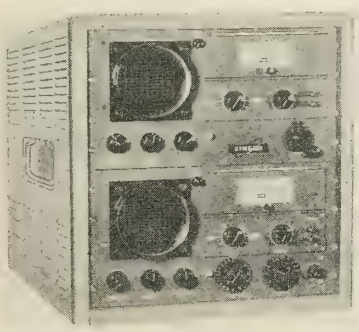
A pre-detection diversity-combining telemetry system using a Nems-Clarke type DCA-5000 combiner is being marketed by Vitro Electronics. This system is designed to combine two five mc IF signals from two telemetry receivers of the same type as 1455 or 1456 series or equal.

The IF center frequency of the DCA-5000 output is 750 kc and can be fed directly to an existing wideband tape recording machine. Other center frequencies can be supplied. The combiner has a bandwidth of 1.2 mc and can handle most telemetry signals. The pre-detection diversity combiner shows an improvement of signal-to-noise ratio of three db when used as a dual channel combiner and equal signal-to-noise ratio in each channel when compared with single channel reception.

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Telemetering Indicator

A dual panoramic telemetering spectrum analyzer, Model TM1-23, with two simultaneous calibrated spectrum displays of FM/FM telemetering subcarrier band data on two CRT's for rapid analysis of IRIG FM/FM telemetry data, has been developed by Singer Metrics Div. of The Singer Mfg. Co. The unit is used for monitoring the input and output subcarrier channels of telemetering links for preflight checkout and calibration, in-flight performance valuation as well as for post-mission date reduction analysis.



One indicator, designated Model TMI-2/L, covers the entire IRIG subcarrier band from 35 cps to 120 kc at a 1 cps rate, with a directly calibrated log scan pinpointing all IRIG channels for rapid VCO pre-emphasis settings, noise, missing channels, and other unwanted effects.

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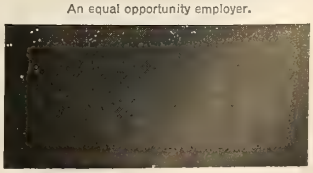
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This issue will be the first in-depth analysis from an industry viewpoint of DOD's new procurement and engineering philosophy which has definitely modified the roles of the joint chiefs, the services and the service secretaries in major weapons systems policy, R&D and procurement decisions.

Three sections in the Military Systems Issue:

● **DOD Policies**—McNamara's Pentagon Reorganization / DOD Budget and Programs / Procurement / Research and Engineering.

● **DOD Operations**—How a Weapons System is Approved / How Industry Can Operate at the DOD Level / How Other Agencies Affect DOD Decisions / How Well is the Pentagon Reorganization Working?

● **The Decision Makers;** the role and influence of eleven key DOD offices and agencies in missile/space decisions—Secretary McNamara's Office / Comptroller Office / Research and Engineering Office / Procurement Office / Joint Chiefs of Staff / Office of the Secretary of the Air Force / Office of the Secretary of the Army / Office of the Secretary of the Navy / Defense Supply Agency / Defense Communications Agency / Institute of Defense Analysis.

● **The Military Systems Issue** will be must reading for every one of over 41,000 paid M/R subscribers in industry and the military. Advertise in M/R's March 25 issue to gain maximum exposure for your products and capabilities.

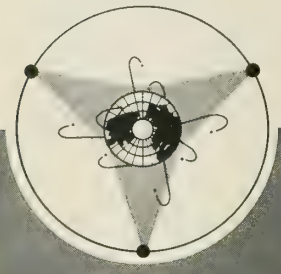
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Issue Date: March 25, 1963 ***Closing Date: March 4***

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SPACECRAFT ANTENNA DESIGN ENGINEER

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Please write in full confidence to Mr. H. T. Curran, Box 77-WC, ITT Intelcom, Inc., 5817 Columbia Pike, Bailey's Crossroads, Va. (15 mins. from downtown Washington, D. C.)

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names in the news

John N. Nilles: Appointed manager, special projects office in Aerospace Corp.'s Systems Research and Planning Div., Los Angeles. **Fred K. Guest** appointed assistant director, systems integration and evaluation for the *MMRBM* program in the Technical Div., San Bernardino Operations.

Dr. Stuart Ridgway: Appointed technical director of General Technology Corp., Torrance, Calif.

Myron A. Hamman: Named general sales manager of the Bunting Brass and Bronze Co., Toledo.

Robert D. Schmidt: Named corporate representative for Control Data Corp.'s R/D Special Systems, System Sciences Div., Los Angeles.

Allan Cork: Joined Packard Bell Electronics, Los Angeles, as director of manufacturing, Space and Systems Div.

David B. Newman: Named to the new post of manager, advanced programs, LFE Electronics, division of Laboratory for Electronics, Inc., Boston.

J. J. Alkazin: Appointed administrative assistant to the vice president-engineering at Ryan Aeronautical Co., San Diego. **Leon W. Parma** joined the company as executive assistant to the manager of advanced product planning.

James J. Ling: Appointed chief executive officer of Ling-Temco-Vought, Inc., Dallas.

Myron P. Roebuck: Named vice president and corporate director of marketing, Dynatronics, Inc., Orlando.

Dr. Robert C. Langford: Director of General Precision's Aerospace Research Center, appointed to the National Aeronautics and Space Administration's Research Advisory Committee on Communications, Instrumentation and Data Processing.

N. Thomas Berry, Jr.: Appointed general sales manager for Regency Electronics, Inc., Indianapolis.

Malcolm Young: Promoted to the newly created post of chief, quality assurance and reliability of Erie Resistor Corp., Erie, Pa.

W. V. Warner: Appointed director-government marketing of Universal Match Corp., New York City.

Walter J. Bergman: Appointed manager-Huntsville operations of Vitro Corp. of America's Vitro Services Div.

Dr. Norman E. Friedmann: Elected vice president, California operations of ITT Federal Laboratories, San Fernando, Calif.

Charles Cole: Appointed sales manager of Vidar Corp., Mountain View, Calif.

Jack N. Brown: Appointed director of marketing for the Space-General Corp., El Monte, Calif.

Dr. Charles B. Wakeman: Named director of electronics research for the Electronic Products Div. of Corning Glass Works, Corning, N.Y.

Donald J. Murphy: Named president of United ElectroDynamics, Inc., Pasadena, Calif.

Walter Williams: Named division manager of Dyna-Therm Chemical Corp.'s Thermal Space Div., Los Angeles.

Dr. Gardner L. Tucker: Promoted to director of research, International Business Machines Corp., New York City.

John D. Heronemus: Appointed manager of the Aerospace Ground Equipment Section in the Engineering Services Dept., Government Products Div. of Adler Electronics, Inc., New Rochelle, N.Y.

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FEBRUARY

Electronic Sales-Marketing Assn., First Annual Convention, Americana Hotel, New York City, Feb. 11-13.

Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques, UNESCO Bldg., Paris, Feb. 11-15.

Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory, Engineers Club, Dayton, Ohio, Feb. 12-13.

International Aeronautics and Space Fair, Congresses and Competitions, Ibirapuera Park, Sao Paulo, Brazil, Feb. 15-Apr. 14.

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Colo., Feb. 18-19.

Conference on Crew Escape Techniques for Aerospace Vehicles, sponsored by Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Feb. 19-20. (Secret)

American Society for Quality Control Annual Reliability Symposium, Statler-Hilton Hotel, Los Angeles, Feb. 20.

1963 International Solid State Circuits Conference, sponsored by IRE, AIEE, and University of Pennsylvania, Philadelphia, Feb. 20-22.

American Society for Quality Control, Quality Control Conference, Flamingo Hotel, Las Vegas, Feb. 21-22.

Society for Nondestructive Testing and Southwest Research Institute Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, Granada Hotel, San Antonio, Tex., Feb. 26-28.

Society of Plastics Engineers, Annual Technical Conference, Biltmore and Statler-Hilton Hotels, Los Angeles, Feb. 26-Mar. 1.

American Physical Society Meeting, Rice Institute, Houston, Feb. 28-Mar. 2.

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The Proud Men

The subterranean men were proud men, sure of their ability. They also had developed to an almost sublime degree the capacity to forget the sum total of their task and to concentrate on their small role. They were a hard-working, magnificently trained team.—FAIL-SAFE.

THIS QUOTATION from the best-seller by authors Eugene Burdick and Harvey Wheeler refers to the Air Force men manning the underground missile silos of the United States.

The book is fiction. The men are real. As you read this, there are men of the USAF buried in concrete catacombs deep under the Western prairies, alert and ready for the signal which they hope will never come.

Many of them wear silver wings that are reminders of the days when they flew and fought in a blue sky which now they cannot even see.

Some of them may doubt the wisdom of policies which brought them down out of the wild blue yonder and entombed them as guardians of these fantastic underground cannons. Doubting or not, they remain on the alert and try to forget what they may be called upon to do.

The powerful ICBM deterrent protects this nation not only because of the men who man it but also because of the men who designed it, built it and installed it.

The *Minuteman* ICBM was developed on the tightest schedule ever presented to a military/industry team for a major weapon. In the face of great technological advances required, some 14 months was chopped from the original planning.

"When we set our specifications," says a top-level Air Force program officer, "we went what we thought was years beyond existing technology. But the contractors didn't realize that so they came up with just what we asked for."

Primary responsibility for the installation of the missiles at their sites was placed in the hands of a specially-created Site Activation Task Force (SATAF), a select group of Air Force personnel assigned to Ballistic Systems Division, Air Force Systems Command.

A SATAF unit was assigned to each *Atlas*, *Titan* and *Minuteman* site.

Responsibility for digging the silos and for basic construction was assigned to the Army's Corps of Engineers. Again, a special unit was formed—Corps of Engineers Ballistic Missile Construction Office (CEBMCO). Contrary to many published and unpublished stories, BSD and SATAF officers have high praise for CEBMCO activities.

These military units worked closely with the civilian contractors involved. The construction contractor at Malmstrom AFB, Fuller-Webb, put down the greatest percentage of the *Minuteman* silos during the coldest winter recorded in Montana in more than 50 years. Work crews were given cold-weather survival training. Their cars were equipped with survival kits. Helicopters were used on several occasions to evacuate personnel from snow and ice-bound sites.

In spite of all this, the Wing I construction work was finished ahead of schedule.

The *Atlas F* program met other problems. There was an explosion at one base and a silo that wanted to be a well at another. There were leaky silo doors and rattlesnakes which enjoyed the warmth of diesel generators. Bits of hardware refused to work—a serious check valve problem turned up in a loading system, erratic sensors kept insisting more LOX was needed when the tanks were full, rollers on the elevators cracked and galled.

In early phases of the *F* program, costs and manhours got pretty well out of hand in some areas. Close coordination of SATAF units with parallel General Dynamics/Astronautics teams helped solve some of these problems. As the learning improved, experience at one site was passed along to the next.

Both SATAF and GD/A crews became experts at bypassing a specific step when parts didn't arrive, tooling was still in use at another base, or final approval of a piece of equipment awaited further flight-testing of the missile.

The *Titan* program is equally difficult.

BUT DETERMINED MEN brought the mammoth ICBM complexes into existence and determined men now stand guard in them.

Construction drifters or boomers, as they are known in the construction trade, are moving on to new missile sites or back to their old jobs. Some came from oil fields, some from building trades, some from shipbuilding centers. They brought and acquired exceptional skills.

"They've always drifted and always will," says an Air Force officer. "They seem to take care of themselves. But it would have been impossible to accomplish the missile program without them."

To all of these proud men, the military site teams, the construction workers, the men of the USAF now manning the silos, we extend on behalf of the nation and the industry a "Well done!" for a major contribution to the peace of the world.

William J. Coughlin

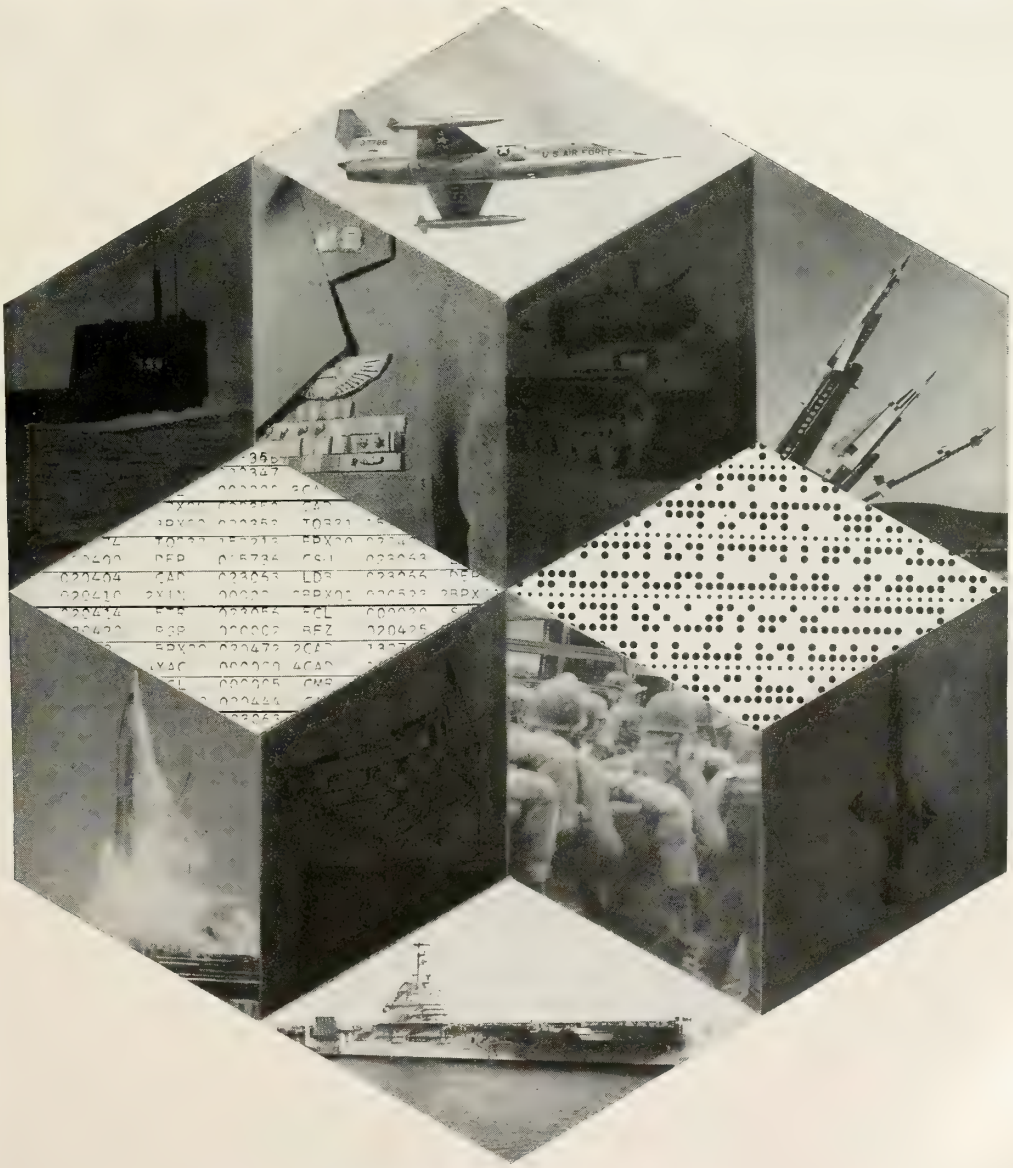
Decision-Making: Deploy or not?...When and where?

The costly, complex weapons systems of today make such a decision far more difficult than in the past. World-wide forces and events are frequently involved. The time for decision has been compressed, the information on which it must be based has been multiplied in volume, variables, interrelationships. This new era of decision-making has led commanders and governmental leaders to make use of man-machine systems which provide information processing assistance. SDC's staff of scientists, engineers and computer programmers have been developing these huge systems for more than eight years. They help develop the system itself, not the hardware within the system. Specifically, they analyze system requirements, synthesize the system, instruct computers which are the core of the system, train the system, evaluate the system, adapt it to the changing needs of its users. And in so doing, they consider the interaction and effect of men, doctrine, tradition, training; of organizations, chains-of-command and chains-of-succession; of communications, traffic centers, command posts, computers and displays. Human factors scientists, operations research scientists, systems-oriented engineers, and computer programmers interested in joining this rapidly expanding field and working in a close interdisciplinary effort are invited to write Dr. H. E. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D. C.; Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."

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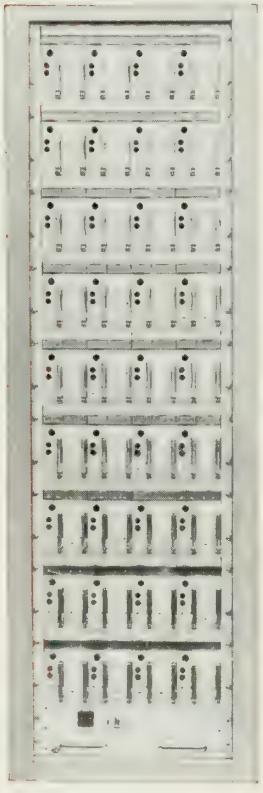
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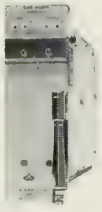
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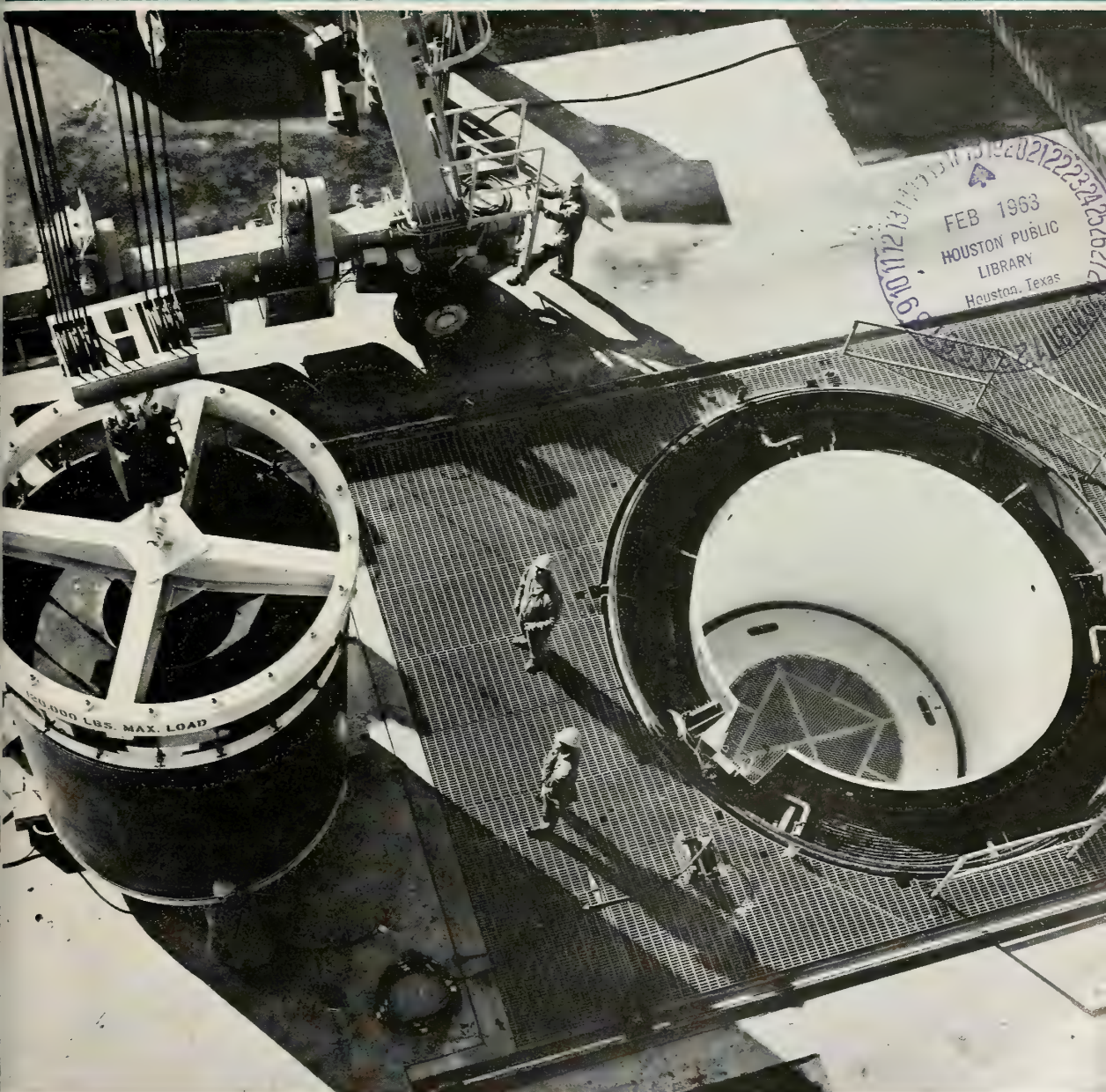
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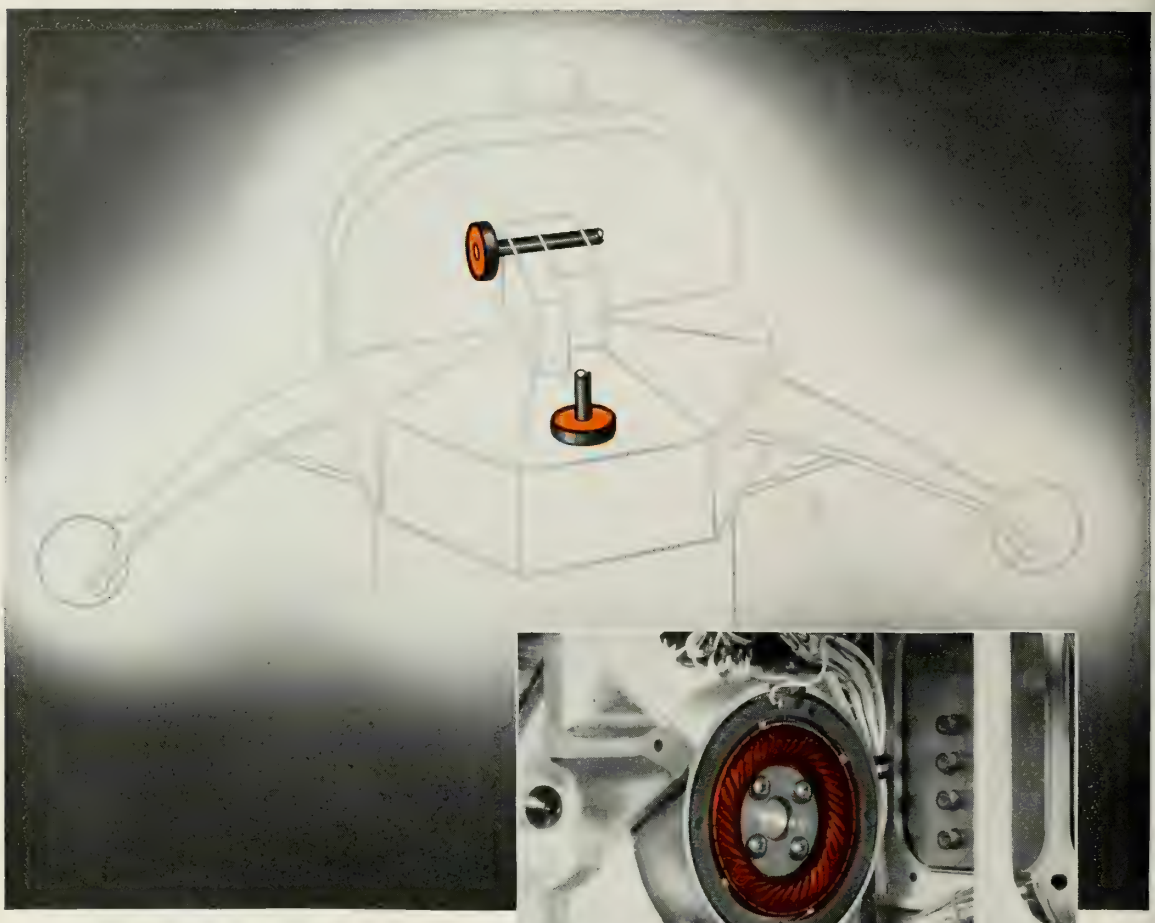


Photo — Courtesy of Ball Brothers Research Corporation

Inland Gearless Torquers help keep "OSO" instruments locked on the sun

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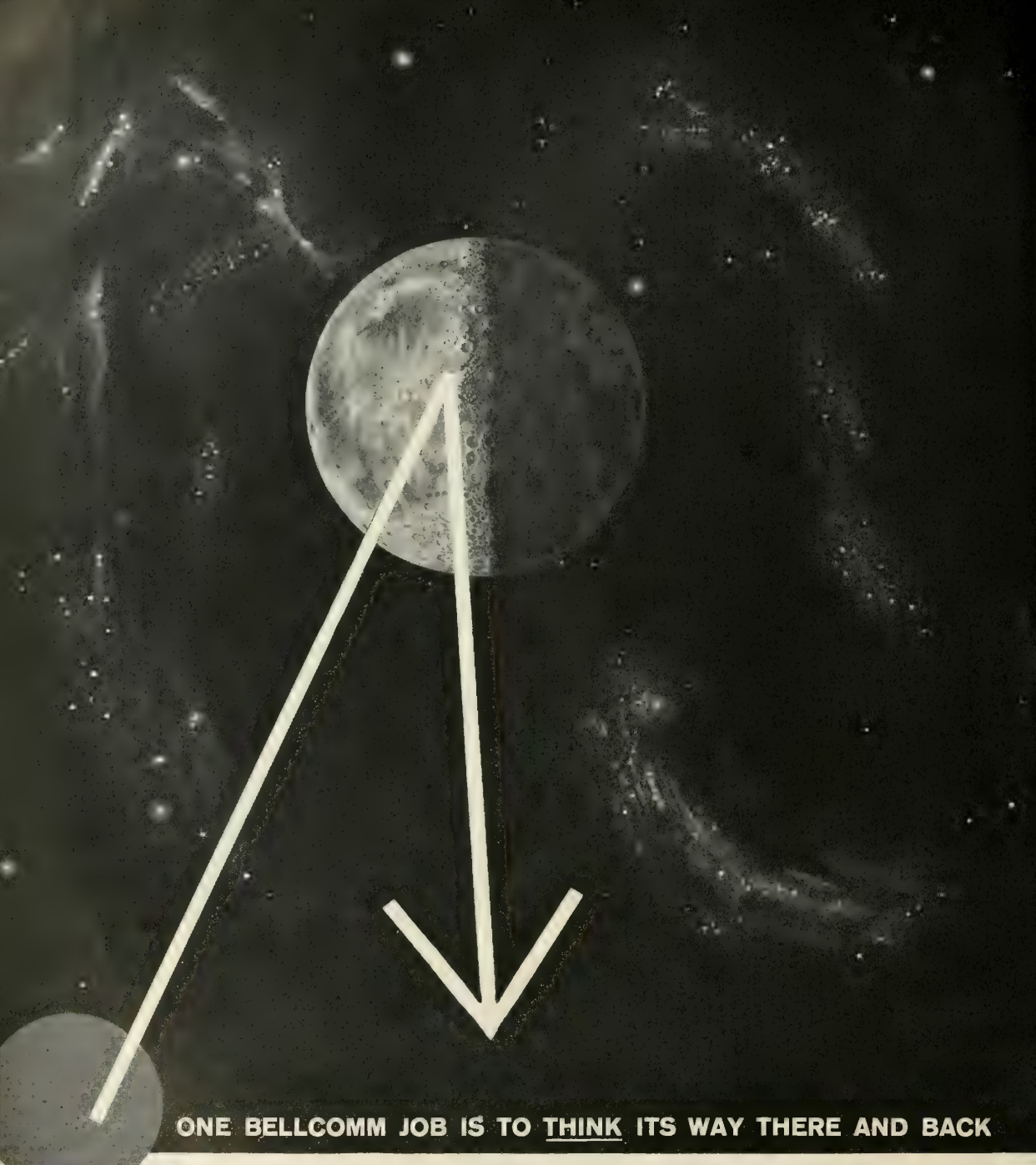
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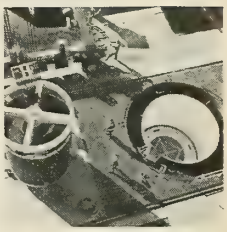
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THE COVER

Loaded solid motor segment shown after removal from casting and curing pit at United Technology Center, Sunnyvale, Calif. The firm will test the first 120-in. solid motor for the Air Force Titan III within a week. See p. 36.

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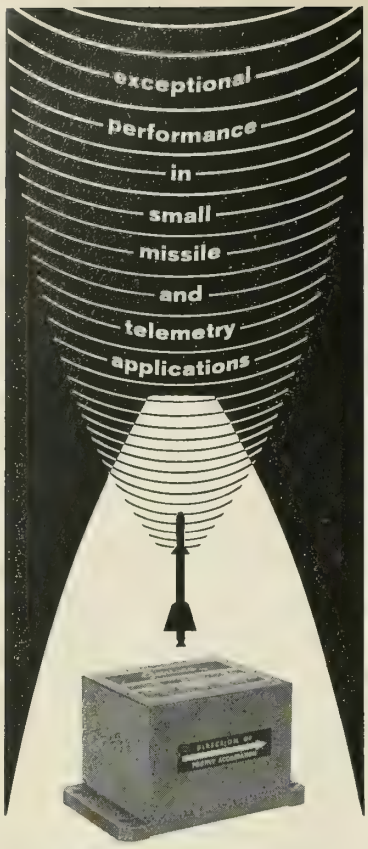
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letters

Skybolt Champion

To the Editor:

I cannot agree with your Jan. 7 editorial ("The Meaning of *Skybolt*").

I was very much surprised at your stand on this issue. Only one point do we agree on, truly, the scrapping of *Skybolt* was not for technical reasons. The reason is most apparent, to quote from your very excellent article of Dec. 24 ("DOD Says AICBM Feasible," p. 14):

"Basically, leaders in the Administration feel that past U.S. weapon system developments have actually aggravated the arms race and contributed to the instability of the deterrent concept. Past U.S. actions, they claim, have actually forced the Soviet Union into weapons developments they probably would not have undertaken otherwise.

"Therefore, several potentially unstabilizing weapons will not be developed and deployed because of the conviction that such action will be met by similar restraint in the Soviet Union. . . ."

How unrealistic can one's thinking be? The Soviet Union has never been forced into weapons development or deployment it did not want to go into anyway—the Cuban crisis is clear evidence of that.

Looking at it logically, without all of its political overtones, *Skybolt* is an ultimate weapons system. It is ultimate by virtue of its being the Mobile Launch concept in its truest form.

Ultimately, with an atomic aircraft, one that could stay aloft for very long intervals, we would have the truly Mobile Ballistic Missile, one that would be superior to the *Polaris* concept.

Glen A. Williamson
Nike-Zeus project
Kwajalein, M. I.

Soviet Abilities

To the Editor:

Your Jan. 14 editorial ("The Soviet Threat") makes some excellent points, but its tone almost indicates that you feel that the Russians are 10 feet tall.

You object to the Congressional Joint Committee's finding that the Soviet economy cannot support an ICBM program, a missile defense program, and a space program simultaneously. No doubt they can—if they are allowed to stretch out or bypass one or another of these programs at their convenience.

However, the Committee's finding may well be true if the Soviets are *not* allowed these luxuries. Perhaps the finding should have been expressed another way: that the Soviet economy cannot support three *competitive* programs, if the competition is with us. The USSR is straining its economy to have ICBM and space programs; we are not straining ours. We have idle industrial capacity; the Soviets are using all of theirs and are trying to expand it. They can be made to face choices between missiles/space, consumer goods, and capital goods production; we are still in a position to have all three without serious sacrifices.

The advantages in the three "races" still lie with us, although (as I think you will agree) we keep failing to exploit them fully. The *Gemini* program was cut back (or stretched out) partly in order to avoid a procurement conflict between space and the military over *Titan* boosters. If we had accepted this "conflict" we might have forced a similar conflict on the Soviet Union—they, too, have to "decide" between space and the military. We might have been able to hobble their programs for developing "small" ICBM's like our *Atlas* and *Titan*.

The Soviet ability to support "all three" programs is still marginal, and may not yet deserve your "confidence" in it. *Our Government is neglecting a potentially powerful economic lever against Soviet military and economic power.*

You are right that the taxpayer's dollar should be spent on programs to meet a real Soviet threat, but appraisals of Soviet strength do not cost a mil.

Nicholas Rosa
Los Angeles

Lo, the Poor Engineer

To the Editor:

Whether or not you have the courage to print this letter, I should like to hear your reaction to my contentions:

1. Engineers are held in contempt by management, the armed forces, the blue-collar workers—and they are treated accordingly.

2. Engineers are morons in the field of human relations, particularly when it comes to looking out for their own realistic interest.

3. Engineers should form one immensely powerful group instead of the loose organizations which prey upon each other in childish jealousy.

4. Engineers treat one another with discourtesy, and make employment interviews degrading experiences.

5. King-pin engineers like Von Braun, Von Karman, Rickover do the least for their fellow engineers.

6. Young engineers are the stupidest of all. Blinded by glittering promises, and large beginning salaries, they think that never, "but never" will they be affected by those 15%-30% cutbacks which are the most idiotic waste of talent, time and money.

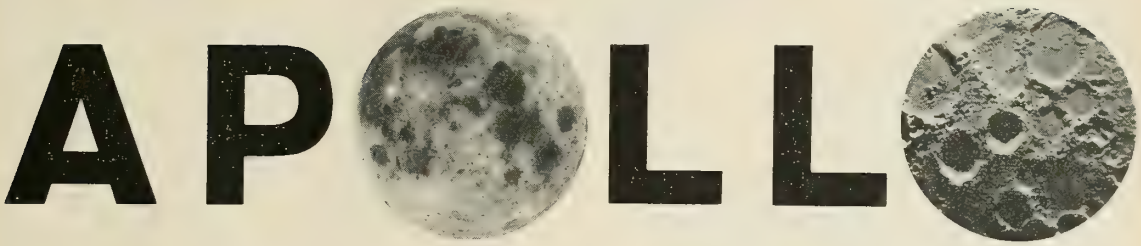
7. The government of the United States has lowered the status of the engineer to below the level of the migratory farmworker, by permitting *phase-outs* at a moment's notice, often without severance pay or any other benefits.

8. Engineers may get to the Moon, but they will get nowhere here on Earth.

Tony Berger
Burbank, Calif.

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The Countdown

WASHINGTON

McNamara Takes First-Hand Look at X-20

Secretary of Defense Robert McNamara is taking a personal interest in the fate of the *Dyna-Soar (X-20)* program. He is planning a visit to some plants involved in the project, including Boeing Co. and Martin Co. Air Force sources remain gloomy over future prospects for *X-20*.

Budget May Cause Gemini, Apollo Overlap

There are growing fears in NASA that the first manned orbital *Gemini* flight may overlap the first Earth-orbital test flight of *Apollo*. *Gemini's* launch schedule now is indefinite because of budget problems. Some officials believe the first orbital flight could slip into the last half of 1964. This is the same period in which *Apollo* flights are to begin.

Changes Imminent in Tiros Program

Two innovations in the *Tiros* weather satellite program now appear certain. One calls for a near-polar orbit to provide data over almost all the Earth. The other, use of eccentric-orbiting satellites, would permit viewing the Earth and its cloud cover from a sufficient distance to scan the entire disc at one time.

AF Proposes Expanded Gemini Project

Air Force is drawing up a plan for its participation in the *Gemini* program at a cost of somewhat less than $300 million over the next four to five years. The military program will be presented shortly to the board coordinating the joint NASA-AF participation in *Gemini*. The board, which held its first meeting on Feb. 8, includes Associate NASA Administrator Robert C. Seamans and AF Asst. Secretary Brockway McMillan as co-chairmen; Gen. O. J. Ritland; DOD's special assistant for space, L. L. Kavanau; NASA's manned spaceflight chief, D. Brainerd Holmes; and NASA deputy associate administrator for defense, Adm. W. F. Boone.

Army Breaks Down Its Missile Budget

Army testimony on the Hill shed some additional light on its procurement and R&D programming for missiles. Procurement requests include one for multi-system test equipment (MTE) to serve *Mauler, Lance* and *Shillelagh*. MTE will be able to perform about 85% of the electronic tests required by the missile systems. *Nike-Hercules* is to be equipped with HIPAR, a new high-power acquisition radar, and anti-tactical ballistic missile capabilities. R&D for this is programmed at $3.9 million. *Mauler* is earmarked for $83.3 million, including $8.9 million for MTE. Funds for *Advanced Hawk* are set at $25.9 million.

Air Force Evaluating Dyna-Soar Tracking

Air Force is winding up an evaluation of world-wide tracking facilities for the *X-20* program. If the *Dyna-Soar* program continues, it will require addition of super-high-frequency equipment to almost all stations for re-entry communications. In addition, there is some concern over whether nations which have supported civilian tracking stations will cooperate with the military project.

A Saturn Is a Saturn Is a Saturn

NASA has made another switch in the designations of its large launch vehicles. Earlier, *Saturn C-1, Saturn C-1B* and the *Saturn C-5* were re-labeled *Saturn, Saturn B* and *Advanced Saturn*. That's the way they were tagged in the Fiscal '64 budget. Now, NASA is designating them *Saturn I, Saturn IB* and *Saturn V*.

Space Agency to Push Patent Policy

Despite Congressional opposition, NASA is determined to go ahead with its liberalization of patent licensing regulations. The agency has been encouraged by a still-unannounced Kennedy Administration decision to favor a similar policy throughout the government.

Look Out, the Indians Are Coming

JPL scientists have suggested that *Mariner* satellites might act as scouts for *Apollo* astronauts, orbiting in front of them to warn of solar flares. The astronauts then could take temporary protective measures—thus reducing the need for permanent shielding.

INDUSTRY

Convair Designs Little Joe II Launcher

General Dynamics/Convair has designed a unique sectional launcher for *Little Joe II*. Now nearing completion in San Diego, it will be capable of supporting a solid booster and payload with a total weight of 270,000 lbs. and withstanding motor thrusts as high as 800,000 lbs. The launcher itself will weigh about 100,000 lbs. It can swivel through a 140-deg. arc, swing the booster away from the tower, establish down-range aim, and maintain control to within seconds of firing time to compensate for last-minute wind shifts. Firing elevations will be between 75 and 90 deg.

NATO-produced Sidewinder Tested at NOTS

Range tests of a NATO-built *Sidewinder* recently have been completed at Naval Ordnance Test Station, China Lake, Calif. A seven-man NATO observer team from Norway, France and Germany was on hand. NOTS soon will ship telemetry equipment for tests of the NATO missile to France's new facility on the Ile de Levant—an island near Toulon.

INTERNATIONAL

Swedish Army Forms Hawk Unit

First *Hawk* missile squadron in the Swedish Army now is being formed in Gothenburg. Personnel were trained in the U.S. First of the U.S.-built *Hawks* arrived in Sweden late last year under a contract announced as worth $20 million.

British Press Skybolt Substitute

A meeting of Britain's top defense leaders reportedly has given the go-ahead for a British air-launched missile to fill the gap left by the *Skybolt* cancellation. This will be a "hedge-hopping" rocket to be delivered by the TSR-2 aircraft.

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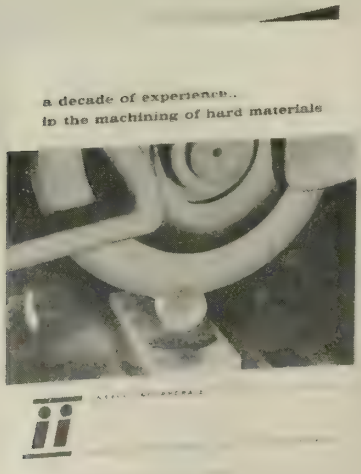
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NASA Re-programs Funds

The Senate Space Committee was advised Feb. 7 that NASA will re-program $17,328,000 in Fiscal Year 1963 appropriations to begin construction of an acceptance test complex for the *S-II* stage of the *Advanced Saturn* at the Mississippi Test Facility. Planned is a two-stand complex of *S-II* test facilities costing between $50 million and $60 million.

NASA said that $20.3 million was committed to the project at this time, leaving the remainder to be justified with the FY 1964 budget request. Earmarked earlier for this purpose was $3 million in advanced planning and design money.

The agency said it was necessary to re-program additional funds to permit construction to begin in time to meet a February, 1965 schedule for acceptance testing of the *S-II*. NASA indicated that $7 million appropriated last year for support of the *S-II* development is also being made available to the project.

In a separate action, NASA proposed to re-program $2.3 million of the funds appropriated for a *Nova* launch complex at Cape Canaveral to provide a "vitally needed" meteorological radar at the same location. The committee was told the radar will provide information on wind loading factors affecting launch vehicles, factors which help to determine the structural design of launch vehicles. It would also aid in controlling vehicles during actual countdown and launches, NASA said.

A third re-programming reported to the committee involves a $3.1 million amount needed to meet increased costs of establishing a new tracking and data acquisition station in northwest Australia. The station is to be a part of the manned flight network.

Shots of the Week

Two successful *Polaris A-3* launches highlighted activities at the nation's missile ranges.

• The first of the Lockheed missiles went 1600 miles across the Atlantic Ocean Feb. 7 in the *A-3* version's first success. Six previous attempts either failed or were only partial successes. The launch was made from a Cape Canaveral land pad.

• The second *Polaris A-3* trav-

elled 2000 miles from Cape Canaveral Feb. 11, and the test was described by the Navy as completely successful. The *A-3* is to have an ultimate range of 2500 n. mi. Distance of the Feb. 11 shot was deliberately planned short of the weapon's ultimate range.

• NASA successfully fired an *Argo D8 Journeyman* sounding rocket from Pt. Arguello, Calif., Feb. 11. The four-stage solid-propellant *Argo* carried a 104-lb. payload with four basic experiments to an altitude of 990 mi.

The probe was intended to determine sources of natural particles in the inner Van Allen belt, and also to study radiation created by last summer's high-altitude nuclear explosions. Data is expected to benefit future manned spaceflights.

• The Air Force launched a General Dynamics/Astronautics *Atlas* from Vandenberg AFB, Calif., Feb. 13. The shot was described as a routine training launch.

Nuclear Missiles Downgraded

A policy statement by high defense officials has cast a shadow over the future of nuclear-tipped tactical missiles.

In a speech given in Los Angeles, Dr. Alain C. Enthoven, Deputy Assistant Secretary of Defense for Systems Analysis, said the line between conventional weapons and nuclear weapons is a "firebreak" and may be the only distinction between limited and all-out nuclear war.

Even use of fractional-yield nuclear weapons in a small war may not be controllable, and could easily escalate, he said. The view seems to indicate that tactical nuclear missiles will not be used except in a full-scale nuclear exchange.

MA-9 Slips to Mid-May

NASA has postponed its *MA-9 Mercury* spaceflight until mid-May because of agency-ordered improvements in the *Atlas* booster.

The flight had been slated for April 2. In its official announcement, NASA said analysis of a failure that occurred during the *Mercury/Atlas* checkout indicated the flight control system wiring as the possible trouble source. General Dynamics then proposed that a new wiring technique be used to improve reliability. NASA approved the change.

Informed sources also claimed that NASA is having technical problems with the *Mercury* spacecraft, but space agency officials denied the report.

Jupiters Out of Italy by April 1

April 1 is the estimated target date for rendering United States *Jupiter* missile bases "non-operative," sources in Rome report.

Three *Polaris* submarines from Holy Loch, Scotland, will have taken up patrol stations by that date, the sources said.

More Tiros Craft Ordered

The space agency is ordering from the Radio Corp. of America seven *Tiros* weather satellites in addition to the eight it has already purchased (M/R, Oct. 29, p. 15). Initial letter contract was for approximately $2 million.

Four of the newly ordered craft will be used by NASA for research and development, and three will be put to operational use by the Weather Bureau. One of the craft assigned to each agency will be used as a backup satellite.

Grand Forks Gets Minuteman

The Air Force has decided that the 150 *Minuteman* missiles requested by President Kennedy for the FY '64 budget will go to Grand Forks, N.D., Air Force Base.

These would bring the number of *Minutemen* in the United States to a total of 950 (M/R, Jan. 21, p. 15).

Syncom Poised for Launch

NASA's *Syncom* active communications satellite was ready to be launched from Cape Canaveral late last week, though slippage could occur.

The 150-lb. satellite will be placed in an orbit so high it will appear to hover over one area of the Earth instead of circling the globe.

Hughes Aircraft Co. is prime contractor for the *Syncom* project.

SMS Systems Study Awarded

Award of the first NASA contract to study overall systems requirements for a Synchronous Meteorological Satellite (SMS) has been made to Republic Aviation Corp.

The $136,640 contract calls for a four-month study by Republic to determine the technical systems needed for 24-hr. surveillance of the Earth's cloud cover, and to identify the major scientific and engineering advances required for ground stations and spacecraft.

As currently envisioned, SMS would be placed in a synchronous orbit at 22,420 mi. altitude with a programmed one-year lifetime.

The Republic proposal was one of 16 received from contractors by NASA's Goddard Space Flight Center, Greenbelt, Md. Twelve of the proposals were for overall studies of the spacecraft and ground station systems; four were for specific SMS subsystems.

Contract Review Board Set

A six-man Defense Department task group is now working under the office of the Director, Defense Research and Engineering (DDR&E) to formulate a contractor evaluation group system planned for the military (M/R, Feb. 11, p. 14).

The group consists of five DOD staff members, including one representative from each service, and one member from NASA.

DOD's system will initially be focused on the engineering development and operational systems development categories, which will consume a considerable chunk of Fiscal '64 defense funding under the Administration's budget proposals.

Robert S. Tucker, assistant director of DDR&E and the official to whom the task group reports, says six contracts already have been singled out as representative of medium and large development programs documenting contractor performance in the two major categories being studied.

The group also is looking over a program from NASA's Goddard Space Flight Center dealing with small solar observation satellites.

Saturn Crawler Contract Let

The Marion Power and Shovel Co., Marion, Ohio, has been selected by NASA to build two giant crawler-transport vehicles for its Cape Canaveral launch complex.

Each vehicle will cost $4 to $5 million, will be used to carry the *Apollo/Saturn V* combination from the vertical assembly building to the launch pad.

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NASA Reveals List of New Study Projects

NASA Associate Administrator Dr. Robert C. Seamans, Jr., revealed last week that the agency has recently approved a long list of new study projects.

Seamans told the 2nd NASA-Industry Program Plans Conference (see special report, page 14) that the studies would be managed primarily by the Office of Manned Space Flight and the Office of Advanced Research and Technology.

He said the studies "would help explain our current thinking in regard to the next generation of space projects."

The following table includes most of the major projects *(under Technical Direction, HQ stands for Headquarters, MSC for Manned Spacecraft Center, ARC for Ames Research Center, MSFC for Marshall Space Flight Center, and LOC for Launch Operations Center).*

OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY

Title	Objective	Technical Direction
Mission-Oriented Study of Advanced Nuclear System Design Parameters	Define essential design requirements for an operational nuclear space vehicle (or vehicles) capable of performing missions conceivable in the 1970-1980 time period.	MSFC
Study of System Concepts and Effectiveness for a Manned Mars Landing and Return	Expose technical problem areas connected with an early manned planetary mission to Mars so that more realistic guidance can be provided in-house research programs in several technical areas.	ARC
Electrical Ferry Vehicles for Manned Planetary Missions	Perform investigations to realistically predict desirable and attainable electric propulsion system characteristics as an aid to guiding research programs leading to design of such vehicles.	MSFC
Nuclear Orbit to Orbit Ferry Vehicle	Study a nuclear Earth-orbit to lunar-orbit ferry so that technical requirements for such a vehicle will be determined as an aid to developing appropriate supporting research progams.	MSFC

OFFICE OF MANNED SPACE FLIGHT

Electrical Power Systems Design for a Manned, Orbital Space Station	Compare and study in detail electrical power systems, including power generation, energy storage and power distribution for a manned Earth-orbiting space station and associated resupply spacecraft.	MSC
Early Manned Planetary Expedition	Provide technical information concerning advanced concepts for manned exploration of the planets in order to derive inputs to be made to NOVA, to the nuclear engine and operational procedures for an early manned interplanetary mission to Mars and/or Venus. This will eventually result in a detailed development plan for an early manned planetary mission compatible with the national launch vehicle program.	MSFC
Advanced Lunar Transportation Systems	Define optimum advanced lunar transportation systems required in the post-APOLLO period for construction and logistic support of a lunar base.	MSFC
Advanced Chemical Orbital Launch Vehicle for Lunar Supply Operations	Determine characteristics and capabilities of Advanced High-Energy Orbital Launch Vehicles with emphasis on lunar supply operations. This will establish an upper limit for the efficiency of chemical Earth-lunar transportation systems.	MSFC
Operations and Logistics Study of Manned Orbiting Space Station	Establish preliminary design requirements for manned orbiting space stations and resupply spacecraft from an overall operational analysis based on minimum resource requirements for a given space station effectiveness.	MSC
Environmental Control and Life Support System Study for a Large Manned Orbital Space Station	Define and specify environmental control and life support systems, requirements, installations, and operational utilization.	MSC
Definition of Configuration, Preliminary Design and Program Definition of a Manned Rotating Space Station	Establish manned orbiting space station program definition and preliminary design of a space station in terms of configuration, on-board systems, and utilization for scientific development and applications activities.	MSC
Definition of Configuration, Preliminary Design and Program Definition of a Zero-Gravity Manned Space Station	Establish program definition and preliminary design of a zero-gravity, manned orbiting space station in terms of configuration, on-board systems, and utilization for scientific development and applications.	MSC
Preliminary Design and Program Definition of a 5-6-Man Modied APOLLO Resupply Spacecraft for Space Station Support	Define required modifications in design of Earth-orbital APOLLO for conversion to a 5-6-man resupply spacecraft and define the program for such spacecraft.	MSC
Definition of Configurations, Preliminary Design and Program Definition of Lifting Body Resupply Spacecraft for Space Station Support	Establish program definition of an advanced logistic spacecraft capable of transporting a crew of approximately 12, and define optimum configuration and preliminary design of resupply spacecraft for two L/D configurations.	MSC
Orbital Systems Integration (Advanced Orbital Operations Concepts)	Develop procedures, techniques and hardware concepts, and specify problems associated with orbital operations, particularly assembling, maintenance and repair, checkout, and launching vehicles from an Earth orbit for advanced lunar and interplanetary missions.	MSFC
Transportation Systems Requirements for a Lunar Base	Study lunar base construction and operational criteria to define transportation systems requirements to establish and maintain a lunar base in sufficient engineering detail.	MSFC
Study of Lunar Environment Construction and Operations Simulator	Produce detailed engineering design data as a guide to construction and operation of an Earth-based facility in which lunar surface and environment conditions can be simulated to test equipment and techniques required to construct and maintain a permanent lunar base.	HQ
Power System Studies for Lunar Base and Associated Mobile Equipment	Produce conceptual designs and performance specifications for an integrated power system to meet all energy requirements of a permanent lunar base, including energy for propulsion of roving vehicles and for processing lunar resource material.	HQ
Medium Launch Vehicle	Define a SATURN C-1 class vehicle replacement for support of Post-1970 space operations in Earth orbit, with emphasis on passenger transportation to Earth orbit, based on two-stage rocket-airplane concepts.	MSFC
Large Launch Vehicle	Investigate possible successors to the SATURN C-5 to serve as primary cargo transport for Post-1970 support of Earth-orbit operations and manned lunar transportation, with emphasis on a reusable first stage to improve the economy of large-scale space transportation.	MSFC
Very Large Launch Vehicle	Contribute to selection, definition, and development of a "first generation" NOVA-class vehicle, and explore advanced concepts for improved efficiency of operation in launching very large payloads in the million-pound payload class with emphasis on reusable launch vehicles.	MSFC
Solid-Boosted NOVA Class Vehicles	Obtain preliminary design of solid-boosted vehicle in 750,000-1,000,000-lb. orbital payload class, using M-1-engine second stage; determine, through analyses and conceptual designs, potential benefits of advanced rocket engines for the liquid propellant stage.	MSFC
NOVA Launch Facilities Study	Determine and define optimum launch facilities and launch operations concept for the NOVA vehicle to be defined by a "NOVA Vehicle System Study."	LOC

Manned Project Choices Nearer

At least one decision is due in the fall, but target date for planetary landing slips toward '80's; a survey of other programs

NASA WILL REACH program decisions before the end of the year on one or more future manned spaceflight projects, but the target for the first manned planetary landing is slipping into the 1980's.

Dr. Hugh L. Dryden, space agency deputy director, told the Second Annual NASA Program Plans Conference that a decision will be made this fall on at least one project such as a Lunar Logistics Vehicle, a Manned Lunar Base or a Manned Orbiting Space Station.

He emphasized that decisions on the projects, as well as on a future manned planetary exploration, will be made not by NASA alone, but in conjunction with a policy ruling by the Kennedy Administration.

Projection of the manned spaceflight program was the highlight of the conference, attended by over 2200 representatives of the missile/space industry.

Other NASA officials briefed the conference on current and future satellite and launch vehicle programs in the Offices of Space Sciences, Advanced Research and Technology, and Applications and Tracking.

Some of the major new disclosures:

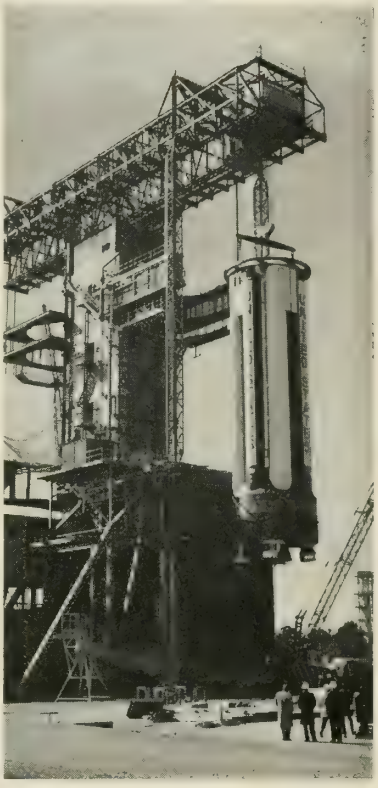
—*Space Sciences* — NASA expects to award study contracts for the *Voyager* unmanned planetary spacecraft and a new heavy Solar Probe in the next few months.

—*Tracking* — Three giant 210-ft.-dia. tracking antennas will be built and the agency expects to spend a total of $349 million in Fiscal '64 on other improvements of its tracking networks.

—*Applications* — Best industry opportunities in this area lie in development of advanced communication satellites and improved subsystems for weather satellites.

—*Advanced Research and Technology* — About 75% of its total Fiscal '64 budget will go to industry in the form of study and hardware contracts.

The indication that manned planetary flights may not be feasible until after 1981 was one of the more important disclosures of the manned spaceflight presentation. It means not only a spreading out of the next major space project after *Apollo*, but also a probable further delay in hardware development of the *Nova* superbooster.



NEW VERSION of Saturn I booster—SA-5—goes into test stand at Huntsville.

Little mention was made of *Nova* during the conference, and no prediction was made as to when its development might begin.

Other details of the Manned Spaceflight portion of the conference:

• Six major subcontractors still must be selected to complete the industrial team for the *Apollo* spacecraft's Lunar Excursion Module. Other contracting opportunities in the lunar landing program include flight simulators for the LEM program and technological improvements in a host of spacecraft subsystems.

• NASA studies have resulted in two possible configurations for a Lunar Logistics System. One would utilize the *Apollo* configuration, with an unmanned LEM spacecraft carrying 5000 to 7500 lbs. of landed payload. The other is a Logistics Spacecraft launched by a *Saturn V* booster; the spacecraft would be a two-stage vehicle with a net landed payload on the lunar surface of 25,000 to 30,000 lbs.

• NASA now believes that a manned orbiting space station providing an orbital lifetime of three months may be feasible. It seems certain that modified *Gemini* and *Apollo* spacecraft will not be large enough to do this job.

• Some current space agency studies are aimed at identifying the types of lunar bases which might be required and the equipment which would be needed for them. Further studies totaling $1.2 million in Fiscal '63 and $2 million in Fiscal '64 will be made.

Future procurement actions in the manned spaceflight program were detailed by George M. Low, director of the Manned Spacecraft Office.

He noted that all of the major contractors in the *Gemini* and *Apollo* command and service module development projects have been selected.

• **Filling the team**—In the LEM program, however, Low said six major subcontracts will be awarded in the near future. They include stabilization and control, parallel development of descent propulsion, electrical power, communications, instrumentation and radar. A major subcontractor for LEM flight simulators still must be selected.

Low also told the meeting that NASA needs help from industry in developing improved technical systems in such areas as lower-weight power supplies, communications during reentry, bioinstrumentation, heat exchangers and insulating materials, ablative materials for rocket nozzles, impact and vibration attenuation systems, and welding techniques to reduce spacecraft leaks.

He said NASA now has acceptable solutions in most areas, but that improved systems are needed and would be incorporated into Project *Apollo* if time and money permit.

• **Four entries**—The status of fu-

ture manned spaceflight projects was covered by Dr. Joseph Shea, deputy director, Manned Spaceflight (for systems).

He said four major programs—Lunar Logistics Vehicle, Manned Orbiting Space Station, Lunar Base and Manned Exploration of the planets are under study.

In discussing the Manned Orbiting Space Station, Shea said, "the clear conclusion is that man's tolerance for weightlessness must be established as soon as possible.

"We are studying methods of accomplishing a three-month flight by modifying a *Gemini* or *Apollo* spacecraft to provide for longer stay times, using a *Saturn*-class launch vehicle to place it in orbit. A major uncertainty in this approach is whether either of these spacecraft provides sufficient room to perform the experiment," he said.

He added that one estimate of the amount of space required for adequate monitoring of the station's astronauts is 3000 cu. ft., roughly eight times larger than the *Apollo* Command Module.

Shea said NASA will continue to study the smaller stations as well as the larger multimanned space stations capable of providing artificial "g" for more extensive missions.

About $2.5 mililon will be spent on the studies in Fiscal '63 and $2.8 million in Fiscal '64.

Turning to the Lunar Logistics Systems, the official emphasized that it is not yet an approved program. Other NASA officials told MISSILES AND ROCKETS a decision on the program could be expected about the middle of 1963.

Shea said the study effort thus far had resulted in the LEM and logistics vehicle configurations. About $400,000 for further studies is in NASA's Fiscal '64 budget request.

He said use of the LEM technique requires no new booster stages and is the least expensive program. The Logistics vehicle with the *Saturn V* would require development of new stages and would be far more expensive.

• **Hard choice** — In the manned planetary program, Shea said, "it is fair to indicate that we are not now certain that a manned planetary landing is feasible before the 1980's."

He said the choice apparently lies between trying for a single 1974 window or not attempting a planetary landing until after 1981. He said launch windows from 1977 to 1981 are not usable because of the greater transfer energy required.

Spacecraft and mission profile studies in this area will total about $750,000 in Fiscal '63 and $1.5 million in Fiscal '64. ⌗

Unmanned Probe Studies Due

NEXT MAJOR procurement actions in NASA's unmanned scientific space exploration program will be the award of study contracts for the large *Voyager* interplanetary spacecraft and a new 300-lb. Solar Probe.

Looking farther into the future, Lunar and Planetary Program officials anticipate development of spacecraft capable of trips to Jupiter, Saturn, and Pluto in the 1970's, flights out of the plane of the ecliptic, and missions to explore comets and asteroids.

Other officials also predicted that the 1967-71 period would see a very heavy program of scientific exploration with Earth satellites in support of Project *Apollo*.

Hardware development of an *Advanced Solar Observatory* also will begin as soon as the current study contracts are completed; the first launch is scheduled for late 1966 or early 1967.

Other programs in which NASA is interested include a radio astronomy satellite; a system of satellites and probes which would make simultaneous measurements of the population of charged particles and strength and direction of the magnetic field at widely separated points in the solar system and the possibility of flying one very heavy satellite inside another to study the gravitational field of the Earth.

Oran W. Nicks, director of Lunar and Planetary Programs, told the NASA/Industry Conference that current planning calls for *Voyager* flights no earlier than 1967. He said that the spacecraft is planned to orbit either Venus or Mars and to land capsules on either planet.

"If the *Saturn 1-B* vehicle is used," Nicks said, "*Voyager* may weigh on the order of 7000 lbs. Industry studies of possible designs are planned to begin before summer, with proposals to be solicited by NASA headquarters."

He said that the heavy solar probe is being initiated to augment the results of the current *Pioneer* probe program. He said that the Ames Research Center will solicit proposals for industry studies in the spring of 1963.

• **Other plans**—Nicks gave the meeting of missile/space representatives this review of other lunar and planetary programs:

—*Mariner*—The spacecraft for Mars/Venus capsule entry and landing is currently under study. The spacecraft will be launched by an *Atlas-Centaur* and will weigh in the neighborhood of 1000-15000 lbs. "Final configuration and plans for implementing the program are expected by early spring."

—*Surveyor Lander and Orbiter*—Some consideration is being given to exploring special applications for *Surveyor Lander* spacecraft for follow-on missions. The *Surveyor Orbiter* will be an outgrowth of the lander vehicles; its design is currently under review.

—*Ranger*—Detailed design review of the lunar hard-landing spacecraft is being conducted, and the next series of launches will begin in late 1963.

—*Pioneer*—The Ames Research Center recently invited firms to submit bids by March 4 for the development of the small solar probe. It will weigh about 120 lbs. and will be launched by the *Delta*.

• **Earth orbits** — A breakdown of NASA's Earth satellite program was presented by John E. Naugle, Director of Geophysics and Astronomy Program.

He indicated that the new projects most likely to be initiated are the *Advanced Solar Observatory (ASO)* and the *ANNA* Geodetic Satellite. He added that the Office of Space Sciences is studying many future projects and expects to maintain a very heavy launch schedule through the next decade.

The *ASO* will weigh 1000 lbs. and be capable of pointing experiments to a point on the Sun with an accuracy of five arc seconds. Hardware development funds are included in the Fiscal '64 budget request.

Other comments on the Earth satellite programs:

—*ANNA*—NASA plans to launch one satellite per year. Technology developed by DOD will be used in the design of the spacecraft.

—*Orbiting Geophysical Observatory (OSO)*—Funding for nine missions through 1966 will total $249 million. NASA plans, however, to launch the spacecraft for at least 11 years. Space Technology Laboratories is currently fabricating three spacecraft.

—*Orbiting Astronomical Observatory*—Three of the spacecraft are now being built under the direction of the prime contractor, Grumman Aircraft Engineering Corp. It is expected that a launch rate of one per year will be maintained.

—*Explorers and other small satellites*—NASA plans to launch about eight per year. ⌗

$349 Million Bolsters System

A NETWORK of three 210-ft., cassegrain-feed antenna stations will join the far-flung NASA tracking and data acquisition complex by 1968. Work on the first prototype unit is scheduled to begin shortly.

Gerald M. Truszynski, deputy director of tracking and data acquisition, outlined a development, implementation and operation program for NASA's three networks at the NASA/Industry Conference. He said the Fiscal '64 budget carries $349 million for programmed support.

The three major networks support Earth satellites, deep space probes and manned spaceflight operations.

• **Earth satellites**—No major augmentations are planned in support of future small satellites, other than normal up-dating and the procurement of certain specialized equipment necessitated by a particular satellite.

But the upcoming generation of "observatory"-class satellites will need additional data-acquisition facilities, said Truszynski. These facilities take the form of large, self-tracking parabolic antennas of 40- and 85-ft. diameters.

In this area, a second 85-ft. antenna is planned for the Rosman, N.C., installation, since the initial unit under construction will soon reach its maximum usage.

NASA is also installing two 85-ft. antennas for the *Nimbus* satellite—at Fairbanks, Alaska, and in Nova Scotia. Installation of the final 85-ft. unit in Australia will begin shortly.

Three facilities, each consisting of a range and range-rate tracking system and associated transponder, will be installed at network locations to handle the *Eccentric Geophysical Observatory*.

PCM telemetry equipment is scheduled at all installations having the new antennas as well as a few other selected sites, Truszynski said, and several Satellite Telemetry Automatic Reduction Systems (STARS) will be installed at Goddard Space Flight Center in the coming year. These will be used to process and reduce data.

Network station communication links will be augmented by wide-band links—100KC to 1 megacycle—to be installed at major data-acquisition sites in North America. The links will be leased from common carriers.

• **Deep space network**—Truszynski noted that the *Surveyor* project alone is generating a 20-to-30-times increase in the data-acquisition capabilities of the present deep space network, which consists of the Goldstone, Calif., Johannesburg, S. Africa, and Woomera, Australia facilities.

Some of the improvements slated for this network include conversion from L-band frequency to the S-band, installation of ultra-low-noise traveling-wave tube masers, and the installation of cassegrain optics in the 85-ft. antennas.

Additional 85-ft. antennas will be added, one in Australia as mentioned, and another at a site in southern Europe. Both overseas antennas and one at Goldstone will be given additional precision ranging equipment.

These improvements to the basic 85-ft. units approach their maximum growth capability, says Truszynski, and the 210-ft. units will take over in 1968.

In addition to all of this, automatic station check-out equipment will be installed to improve the total network system operational efficiency. The NASA expert emphasized that deep space network requirements will continually be pushing the state of the art in such communications systems.

• **Manned spaceflight network**—NASA plans to build heavily on the original 17-station network, in a progressive fashion that will meet upcoming manned missions such as *Gemini*, orbital *Apollo* and the lunar *Apollo*.

The need to handle variable orbital inclinations in the *Gemini* program will necessitate an additional station at the antinodal point in the trajectory. This facility will be located at Carnarvon, Northwest Australia. An FPQ-6 radar is being procured for this station.

The *Gemini* program data level is higher than Project *Mercury's* and this, together with the high number of digital transducers aboard the two-man spacecraft, will make PCM techniques more attractive than the current FM/FM systems.

Only seven of the original manned flight stations will be augmented for *Gemini*—the others will be used essentially as now configured to provide additional voice communication to the astronauts and other backup functions.

Gemini improvements involve installation of dual PCM telemetry systems, dual acquisition antennas, dual digital command systems and a radar coder to provide tracking capabilities of one spacecraft when two are in close proximity.

The same augmented *Gemini* network is planned for support of the orbital *Apollo* program, said Truszynski, with the addition of what NASA calls its unified S-band system.

Use of such a system is dictated by the distances involved in the subsequent lunar *Apollo* program and the need for higher-gain ground and spacecraft antennas. The unified S-band system will enable all functions of tracking, data acquisition, voice and television to be performed by one transponder aboard the spacecraft.

Additional coverage requirements for the *Apollo* missions occurring over wide geographical areas will call for tracking ships. NASA plans to begin procurement in Fiscal '64 of three instrumented ships configured to *Apollo* requirements.

In the NASA/industry relationship for tracking and data acquisition, Truszynski said, the space agency maintains overall systems planning and conceptual design. Industry is called on to supply services necessary to construct, install and operate the facilities.

NASA, he continued, has not installed large-scale government-owned communications systems and does not plan to do so. The practice of leasing communications circuits providing for interstation links should continue. ⁂

1964 Budget Estimate
Tracking and Data Acquisition

Figures are in millions and cover only direct R&D costs

	FY '63	FY '64
SUPPORTING RESEARCH & TECHNOLOGY		
Integrated Systems Study, Development & Test	1.650	2.900
Improvement to Existing Systems	8.732	11.500
New Systems Development	2.218	3.500
NETWORK OPERATIONS		
Satellite Network	11.760	17.000
Manned Flight Network	16.260	24.000
Deep Space Network	7.860	10.000
Launch Area Instrumentation	3.850	5.000
Aerodynamics Test Range	0.450	0.800
Network Communications	10.760	16.000
Data Processing & Handling	4.570	7.700
NETWORK EQUIPMENT		
Satellite Network	10.500	22.000
Manned Flight Network	42.702	84.000
Deep Space Network	7.506	10.000
Launch Area Instrumentation	1.400	3.000
Aerodynamics Test Range	0.710	1.000
Network Communications	2.214	4.000
Data Processing & Handling	2.700	10.000

Industry To Get ¾ of Funds

APPROXIMATELY 75% of the funding programmed for NASA's Office of Advanced Research & Technology will go directly to industry—in amounts totalling $408 million in Fiscal '63 and moving up to $428 million in Fiscal '64.

The entire estimated Fiscal '64 budget for advanced technology reaches $563 million, including costs of personnel and facility operation.

At least 14 new research facilities, ranging from structural dynamics to life sciences, will be under construction during 1964. Boyd C. Myers, II, director of OART Program Review and Resources Management told the NASA/Industry Conference current and planned research hardware represents an initial $198.5-million addition to a plant worth $500 million in 1960.

OART Space Vehicle research will spend an estimated $39.19 million on advanced concepts, structures and design factors. Advanced studies include orbiting labs, recoverable boosters, return vehicles in the 45,000-ft./sec. category and large launch systems. Lifting bodies, noise generation and the effects of radiation, meteoroids, vacuum, zero-g and thermal radiation are among the various subjects to be researched.

M. B. Ames, director of Space Vehicles, told the conference future space vehicles will be expected to provide adequate strength, stiffness, temperature tolerance and integrity against all space hazards simultaneously.

• **Engines funded**—Chemical propulsion research for Fiscal '64 includes $1.574 million for an experimental high-energy engine—relating to a potential hydrogen-fluorine engine system. The broad area of interest in propulsion research runs from thrust-augmented engines through solids to hybrids.

John L. Sloop, director, Propulsion and Power Generation, said his group is actively investigating the next large liquid booster engine—that unit beyond the current F-1 engine extrapolation. Sloop called for new concepts and ideas, since mere scale-up is impractical. Higher and higher operating pressures are needed to keep engine sizes realistic. Another route, he noted, might be the concept of a multitude of combustors feeding a single nozzle.

Sloop said the greatest single problem in propulsion development is combustion oscillation—pressure fluctuations in the combustion chamber which greatly increase heat transfer, leading to failure. An increased effort will be made both to understand this phenomenon and to control or eliminate it.

Large solid engines for Earth takeoff also are under consideration, as are hybrids. Sloop referred to the NASA/Air Force large-solid technology.

• **Sensors stressed**—Dr. Albert J. Kelly, Director, Electronic Systems, particularly emphasized rendezvous sensors and horizon sensors and described the analytic methodology used by his staff in directing research in these two crucial areas.

Proposed Funding for Advanced Technology

(in millions: NASA Personnel & Facility dollars in initial overall figure)

	FY '63	FY '64
OFFICE OF ADVANCED RESEARCH & TECHNOLOGY		
(Total including facility operation & personnel)	386.479	488.989
SPACE VEHICLE SYSTEMS (R&D ONLY)	45.931	61.962
Supporting Research & Technology		
Advanced Concepts	2.425	4.120
Spacecraft Aerothermodynamics	4.830	5.850
Spacecraft Loads & Structures	4.383	6.144
Space Vehicle Environmental Factors	5.055	9.560
Launch Vehicle Aerothermodynamics	3.590	4.440
Launch Vehicle Loads & Structures	4.494	6.148
Space Vehicle Design Criteria	0.500	1.500
SPACE VEHICLE SYSTEMS (FLIGHT PROJECTS)		
Scout Re-entry Heating		
Spacecraft & Support Services	0.4	0.5
Launch Vehicle	1.0	1.0
Project FIRE		
Re-entry Vehicle & Support	5.5	3.4
Terminal Velocity	2.5	0.6
Launch Vehicle	4.0	——
Advanced FIRE		
Spacecraft & Support	——	5.6
Velocity Package	——	1.2
Launch Vehicle	——	1.7
Scout Meteoriod Satellites		
Spacecraft & Support	1.62	0.450
Launch Vehicle	1.5	0.500
Saturn Meteoroid Experiment		
Spacecraft & Support	2.430	4.250
Space Vehicle Recovery		
Flight Vehicles & Support	——	0.950
Secondary Environmental Experiments		
Experiment & Support	——	0.550
Small Space Vehicle Flight Experiments		
Cryogenic Propellants at Zero g	0.800	1.650
Wind Shear	0.114	0.600
Meteor Simulation	0.600	0.600
Trailblazer	0.100	0.2000
Meteoroid Penetration Probe	0.090	0.450
ELECTRONIC SYSTEMS (R&D AND FLIGHT TEST)	20.696	30.362
Supporting Research & Technology		
Guidance Systems	4.590	5.820
Control Systems	3.527	4.928
Communications Systems	3.952	4.585
Tracking & Data Acquisition	1.930	3.488
Instrumentation	2.669	4.252
Data Handling & Processing	2.178	3.539
HUMAN FACTOR SYSTEMS (R&D COST ONLY)	10.060	18.200
Supporting Research & Technology		
Advanced Concepts	0.064	0.900
Human Research & Performance	2.457	4.900
Man-System Integration	2.345	5.600
Life Support	4.503	6.800
NUCLEAR ELECTRIC SYSTEMS (R&D AND FLIGHT PROJECTS)	43.531	68.768
Nuclear-Electric Power Supporting Research & Technology		
Basic Properties	1.670	1.870
System Components	4.790	5.700
Materials & Environmental Efforts	2.428	3.962
Advanced Concepts & System Studies	1.203	1.000
Subsystem Evaluation	——	0.600
Electric Propulsion (Support Research & Technology)		
Electrostatic Propulsion	1.883	1.900
Electrothermal Propulsion	0.603	0.500
Electromagnetic Propulsion	1.714	2.386
Mission Analysis	0.388	0.400
Component Technology	0.439	1.700
SNAP-8 Development (R&D only)	15.100	15.000
SNAP-8 Flight Evaluation (R&D only)	0.843	9.000
Small Nuclear Electric Propulsion & Power Flight Project MECCA	1.850	1.400
Electric Engine Development Project	5.500	8.000
Large Ion Engine	3.800	6.000
Large Arc Jet Engine	0.500	0.500
Small Arc & Ion Engines	1.200	1.500
SERT (RD costs - design & launch vehicle)	5.170	15.350
NUCLEAR ROCKETS		
Supporting Research & Technology Projects	13.339	22.687
Supporting R&T Breakdown		
Rocket Reactor Research	8.060	10.187
Nuclear Rocket Engine Systems	4.826	11.200
Safety	0.200	0.500
Vehicle Technology	0.253	0.800
Project Breakdown		
KIWI-Reactor Test Support Component	2.400	——
KIWI-Propellants	1.670	1.000
NERVA-Engine System Development	4.983	11.000
NERVA-Component & Subsystem Development	19.348	30.000
NERVA-Ground Test	12.690	13.000
NERVA-Propellants	6.196	6.000
RIFT-System Technology	2.336	1.750
RIFT-Subsystem Technology	3.119	9.000
RIFT-System Integration	5.245	1.250
CHEMICAL PROPULSION & SMALL FLIGHT PROJECT	14.469	22.497
Chemical Propulsion Analysis, Aerothermochemistry and materials	5.459	7.525
High-Energy Propellant	2.818	3.306
Advanced Launch Vehicle Engine Technology	1.607	4.474
Advanced Spacecraft Engine Technology	4.035	5.618
Experimental High-Energy Engine	0.300	1.574
SPACE POWER (SUPPORTING R&T ONLY)	10.859	16.524
Solar Cells	2.409	3.350
Thermionic Power Technology	2.519	3.993
Solar Engine Technology	2.064	3.138
Batteries & Fuel Cells	2.147	2.545
Chemical Engines	0.520	1.868
Advanced Concepts (MHD, Thermoelectric)	1.200	1.630
AERONAUTICS TOTAL	43.990	45.126

The control system effort is directed, in part, toward solving the problem of predicting and evaluating manned system performance. The tracking and communications potential of lasers and the problem of penetrating plasma sheaths were also discussed.

Kelly scored the inadequacies of current instrumentation—the variety of transformation prior to data transmission—and pointed to the need for sensing devices producing outputs in digital code form. Here, he said, solutions should be derived from new principles—such as molecular electronics —to arrive at compact and unified transducing devices with adaptive sensing heads.

• **Biosciences blossoming**—Requirements are now being determined for a one-year life support system contract to be let in Fiscal '64, said Dr. E. B. Konecci, Director, Biotechnology and Human Research. He also told the conference that a contract is being negotiated for a completely integrated, five-man, 30-60-day life support system.

Requests for proposals in the areas of advanced anthropometric and non-anthropometric space suits and locomotion devices for free space and planetary surfaces will be made after completion of the current Bell Aerosystems Co. study on manned locomotion.

Konecci and his staff will request proposals in about a month for a "Psycho-Physiological Monitoring System," and new concepts in bioinstrumentation will receive additional attention in the coming years.

Competitive bids on an "In-Flight Maintainability Study," recently generated by a NASA/DOD group to provide information on the performance of man in space, will be sought through Marshal Spacecraft Center soon.

An additional study area to be initiated in Fiscal '64 involves requirements for man-rating the nuclear space vehicles now under development or planned for the near future.

• **Nuclear** — The OART nuclear-electric power effort consists of fundamental and applied research, component development and selected flight tests. Designed to advance the technology in a series of steps, the program is yielding useful systems.

Most of this program is conducted through industry. NASA's OART maintains constant liaison with similar nuclear-electric programs under both DOD and the AEC.

In the thermionic materials area, OART is funding work at the General Atomic Division of General Dynamics Corp. and expects to initiate two major new thermionic materials contracts with industry in Fiscal '64. ⌘

NASA PLANS/applications

ComSats, Weather Stressed

INDUSTRIAL opportunities in NASA's Office of Applications lie primarily in the area of advanced communications systems and new subsystems for meteorological satellites.

The space agency also plans to award a study contract shortly for the design of a data-gathering satellite. Hardware development is expected to begin in 1965.

Other major new satellite projects include the design and development in 1964 of an advanced synchronous communications satellite, and studies of a possible civilian navigation system.

A projection of business opportunities in the space applications area was presented to the NASA/Industry Conference by A. M. Greg Andrus, acting chief, Communications Satellite Technology, and William K. Widger, Jr., chief, Operational Meteorological Satellites.

In the communications program, Andrus said, the exploratory studies on an advanced intermediate-altitude repeater satellite have been made and "we are still in the process of identifying the various elements of research and advanced technical development which must be completed prior to firming up a flight program." Hardware development and flight plans do not exist, he added, primarily because of the need for further studies and experience with active repeater satellites.

In the high-altitude ComSat area, he said that "in 1964 and beyond we plan to design and flight-test a new and better version of a synchronous satellite which will have the capability of handling television bandwidths and will orbit in a 24-hour equatorial plane."

Andrus told the meeting no flight program for passive reflector satellites are now scheduled beyond *Echo II*. Instead, he said, the space agency will direct its efforts toward development, test and evaluation of new materials for erectable passive structures, both spherical and non-spherical.

• **New goals**—The NASA official declared that industry can best apply its talents to the extensive program of supporting research and advanced technical development, designed to provide the foundation for new systems with the following capabilities:

—Intermediate-altitude active repeater satellites, with increased communication capability—a multiple-access, passive or semipassive control system for orienting the satellite toward the Earth and powered by solar cell battery combinations or by nuclear isotope power supplies.

—Stationary, fully stabilized high-gain satellites, with high communications gain and long orbital lifetime; station-keeping and attitude control provided by electrical thrusters, with power to be provided by solar or nuclear power supplies.

To achieve these objectives, he said NASA plans to pursue such specific programs as:

—*Antenna technology*—Higher-gain communication antennas would enhance the effectiveness of limited on-board RF power capabilities. NASA plans to award this year a study contract to determine the state of the art in all-electric beam shaping, steering techniques, and tracking.

—*Transmitter and Receiver Technology*—Improvements needed are reduced noise levels below 12-to-14db and increased bandwidth capabilities of phaselock systems beyond the current 3mc.

—*Modulation methods*—Future active satellites must be available to a number of concurrent users, primarily through modulation and multiplexing schemes on a single RF channel.

—*Passive techniques for stabilization*—NASA will continue to conduct studies and hardware development, when feasible, in an effort to get less complex, cheaper and lighter-weight directional antenna systems.

Other major research areas, Andrus said, are frequency utilization, passive structures with improved scatter characteristics, and system comparison and optimization studies.

• **Meteorological systems**—Widger told the meeting NASA plans five more R&D launches of the *Tiros* satellite. In addition, the U.S. Weather Bureau will fund two flight satellites and one backup to fill the gap before *Nimbus* launches begin.

The agency will launch four *Nimbus* satellites; the first flight is scheduled for late this year. The Weather Bureau will also fund four or five additional satellites.

Turning to future programs, Widger said that NASA is also interested in developing an economically practical meteorological rocket sounding system.

He said that while a study contract for a synchronous meteorological satellite was recently awarded, it still has not received program approval by top management. ⌘

MOBILE RADAR TRACKING SYSTEM

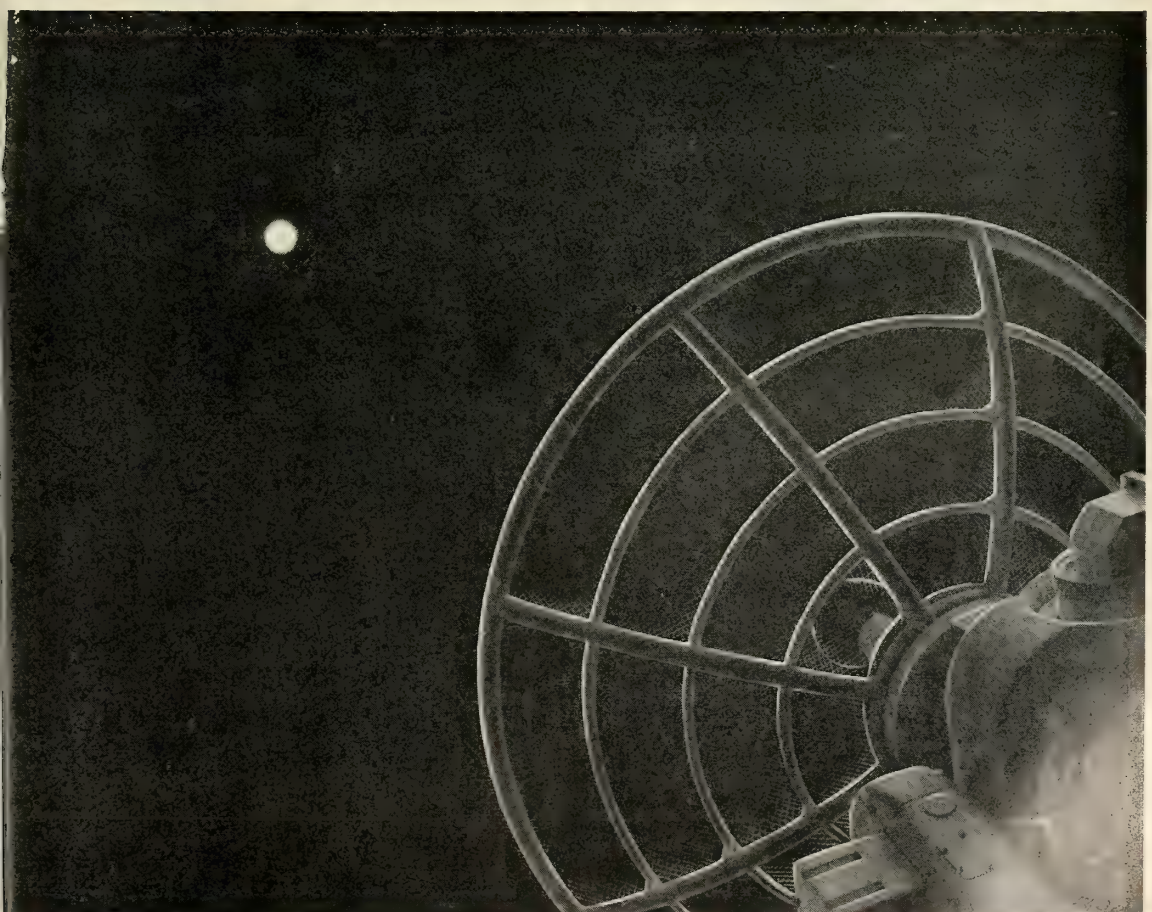
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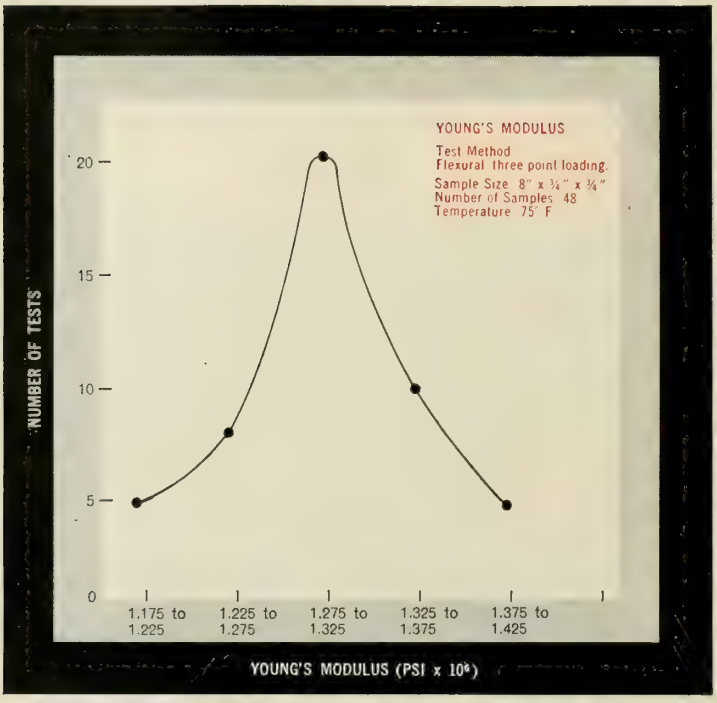
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Technical Countdown

ADVANCED MATERIALS

Too Hot To Handle

Designs inviting high temperatures resulted in the failure of many *Mariner* experiments and overheated *Mercury* capsule interiors, says famed scientist Konrad Buettner, Professor of Atmospheric Sciences at the University of Washington, Seattle. The *Mercury* interior temperatures—averaging between 105° and 110°F while in orbit—could have been cut by 50° to 80°F if the exteriors had been coated white, according to the professor's calculations. He points out that the Soviet *Mercury* counterparts are white. The temperature of the *Mariner* capsule could have been similarly depressed, preventing its batteries from overheating. "I've written to JPL, to Von Braun, and spoken to other NASA officials," he says, "and nobody seems to know why we send up dark spacecraft or who ordered it that way. It's becoming a fascinating detective story trying to find the answer."

New Uses for Depleted Uranium

Depleted uranium, that by-product left when the fissionable material has been stripped away, is being used for radiation shielding purposes. Engineers at Atomics International, a division of North American Aviation, Inc. are taking advantage of the depleted uranium's high density and machining ease to fabricate specialized radiation shields of intricate shapes. About equal in density to tungsten, depleted uranium is much cheaper, and finished products pose no health or radiation problems. Normal precautions basic to the working of other heavy metals have to be taken in processing.

Design Error Slows Nuclear Test Stand

NERVA Engine Test Stand 1, which is to be "essentially complete" in March according to Space Nuclear Propulsion Office officials, is actually 18 mo. behind schedule because of a mistake in the design of the exhaust duct in which high-altitude starts are to be simulated. Designers underestimated the heat flux from hot hydrogen at supersonic velocities at an elbow in the duct. The problem has been alleviated somewhat by excavating another 14 ft. at the base of the stand to get the elbow farther from the engine. The elbow will have to be made of stainless steel and will incorporate an elaborate cooling system. Stainless steel is undesirable in a nuclear facility because it becomes highly radioactive under neutron bombardment. The test stand delay will have no effect on the *NERVA* program because the engine is even farther behind schedule.

Martin to Build Telescopic Space Structure

A telescopically expandable space structure will be designed, built and Earth-tested by Martin Co.'s Denver Div. under a $483,000 contract from the Air Force Systems Command Aeronautical Systems Div. Results of the 18-mo. program will provide engineering data to space structure fabricators. A space station based on the test system would be a maximum eight feet in diameter and about five feet long in its contracted configuration. The firm's Orlando Div. announced the results of its intense quality assurance "Zero Defects" program over the last seven months. The program is credited with a 25% drop in overall plant reject rate and a 30% cut in scrap costs compared to a similar period in 1961.

ELECTRONICS

Laser Demodulator Developed

A prime component in the receiver portion of any laser communications system, the laser demodulator, is being perfected by scientists at National Engineering Science Co. in cooperation with researchers at Douglas Aircraft Co. The demodulator is a photo tube with the ability to detect modulations at microwave frequencies in visible light. Modulated, signal-carrying laser light waves are received on an electrode having a photo emissive surface similar to that in a photo electric cell. Variations in laser beam amplitude produce variations in the emitted electron stream at the photo surface. These electrons are focused and passed through a microwave waveguide, where fluctuations result in the generation of a microwave signal.

Tag Memory Searching Developed by Goodyear

A computer memory system capable of searching and comparing up to 32,000 10-digit numbers simultaneously is under development at Goodyear Aircraft Corp. The associative memory system is 100 times faster than conventional computer searching methods, and uses a GAC perfected multi-aperture ferrite device. The non-cryogenic system combines the logical operation $\overline{A}B + A\overline{B}$ and non-destructive read-out storage. A portable eight-word, 10-bits/word feasibility model has been built and operational units can handle word lengths up to 200 bits.

SO_2-SO_3 Regenerative Fuel Cell Impractical

Researchers at AiResearch Co. have found SO_2-SO_3 regenerative closed cycle fuel cells to be impractical because of major development difficulties. The problem seems to be that molten salts having good conductivity do not give a reasonable output voltage. An organic sulfate with a lithium sulfate additive gave an output of 0.17v but with a high internal resistance. The comparatively low ideal output voltage of the SO_2 fuel cell (0.3v at 300°F) makes absolute losses very critical in efficiency considerations.

SPACE MEDICINE

Biomedical Monitoring Advances

Two new wrinkles in bioinstrumentation are being examined at Air Force labs. At Wright-Patterson AFB, medics are looking at the possibility of using brain electrical signals (EEG) to warn of mental stress reactions. Meanwhile, doctors at Edwards AFB find that by measuring pulse wave velocity they have obtained the same information as if they had measured blood pressure. They note that present techniques for in-flight blood-pressure measurement are not satisfactory.

Altitude-Adapted Natives Studied by AF

Air Force studies of natives living at high altitudes in the Peruvian Andes show they have significantly higher concentrations of muscle myoglobin and hemoglobin than their sea-level counterparts. Oxidative enzymes and enzyme systems also showed higher activities. Doctors hope to learn how humans adapt to higher-altitude living, and apply this knowledge to preparation for spacecraft environments.

AF Studying Laser Navigation Sensors

ASD evaluation in progress; Sperry and General Precision Inc. disclose new design approaches

by Michael Getler

NEW YORK—Air Force's Aeronautical Systems Division is evaluating an assortment of industry proposals aimed at using laser devices aboard aerospace navigation systems to sense vehicular angular rotation rates.

Proposals went to ASD earlier this month. Unofficially, from five to 10 firms are believed to be taking part. Evaluation of the proposals, now going on at ASD's Navigation & Guidance Laboratory, may lead to hardware contract negotiations in about two months, with an award possible by May.

The AF project is described as a study of "novel techniques for instrumentation of electromagnetic angular rotation sensors based on the Michelson-Gale effect (optical detection of rotation by means of interference pattern shifts). Various lasering action techniques and optical signal processing methods applicable to this effect will be investigated."

There are three major areas of AF interest: 1) selection of a cw lasering process with excellent short-term frequency stability; 2) development of methods of utilizing the change in the path links of two oppositely traveling laser beams, caused by angular rotation, to vary the effective optical cavity length of the laser and cause mode splitting; and 3) development of optical heterodyning methods for measuring the very small beat frequency, to less than 1 cps, between the two oppositely traveling beams.

The AF search for a "non-mechanical gyro" for navigation use could, in many applications, pave the way to even better sensitivity, stability and reliability—at lower cost—than are now available in many highly refined inertial system orientation gyros.

• **GPI approach**—General Precision Inc.'s Aerospace Group in Little Falls, N.J., is known to be developing an optical "gyro," which it has proposed to ASD and other Government agencies. The firm says studies in progress for about a year indicate the device holds considerable promise in terms of accuracy and reliability.

Though all the optical systems exploit similar operational advantages of the laser medium, the General Precision project points up the variety in design approaches by industry companies. GPI uses an equilateral triangular resonator in its experimental model, with the corner mirrors located only 138.56 cm apart. The laser is of the helium-neon type, operating at 6328 Angstroms. GPI engineers told MISSILES AND ROCKETS that use of a triangular resonator should yield significant advantages in simplicity of alignment, high electrical-Q (energy storage), and minimization of optical aberrations.

Using the GPI approach, they report, work to date indicates that an instrument with a 10-cm radius (from triangle center to corners) can measure angular velocities of less than .001 deg./hr. Analysis also shows, they claim, that the optical system can be used with considerable accuracy as an angular position reference with respect to inertial space. They report that a resolution of less than ¼ arc sec. and a drift of less than 5 arc sec. per day should be possible.

The firm believes that by the end of 1965 it can realize a fully operational gas-type optical gyro weighing less than 2 lbs. (probably using quartz construction for mirrors and laser tubes), occupying less than 30 cu. in., and requiring about 10 watts of input power.

• **Sperry ring-laser**—Last week, at their Great Neck, L.I., N.Y., facility, Sperry Gyroscope Co. engineers discussed details of a new "ring" laser rotation sensor, which they have proposed to ASD as part of the industry response to the AF probe into these devices.

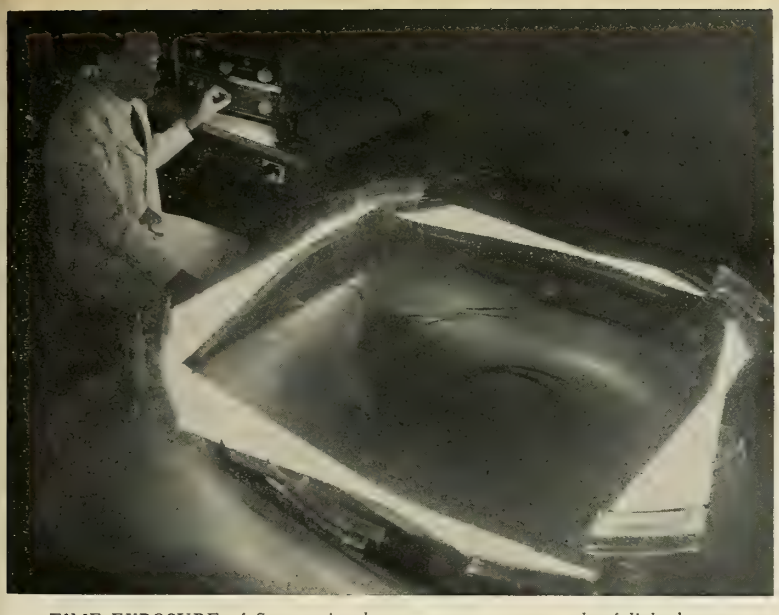
Sperry engineers hesitate to describe the device as a gyro since, as compared to rotating mass units, it operates on a completely different physical principle—that of the constant 186,000 mps velocity of light. They claim that demonstration of the sensor represents a very important application of the laser, one which for the first time fully exploits use of the full-coherence properties of laser beams.

The basic Sperry experiment, first demonstrated last month after a one-year company-funded program, now takes the shape of four 1-meter-long helium-neon gas tubes which together form the square laser cavity. The tubes are glass and about ½-in. in diameter. Four corner mirrors, three reflective and one partially transparent, bend the laser beams around the loop.

In operation, the laser produces two beams at a frequency of 2.61×10^{14} cps. The beams move continuously but in opposite directions around the loop. As the ring, or the platform to which it is attached, rotates, the distance traveled by both beams changes, as does the frequency of each. The beam which now must travel a greater distance to close on itself is lowered in frequency. The opposite is true of the other beam.

As the two beams are picked off through the one partially transparent mirror, they are fed into a photodetector where they are optically heterodyned. The resultant beat frequency is proportional to the rotation rate of the platform. This output, in turn, is used to reorient the vehicle.

• **Applications studied**—Sperry says that although some basic research is still to be done on this basically simple approach to non-mechanical sensing, the point has been reached at which heavy emphasis must now be placed on applications, considering a wide range of trade-offs in design and equipment dependent upon mission needs. Early experiments are encouraging, but several problems must be solved before



TIME EXPOSURE of Sperry ring laser sensor captures path of light beams.

efficient and economical operation can be achieved.

These first experiments performed on the meter-square ring used a laser operating at the helium-neon 1.153 wavelength. Engineers report that operating with helium-neon at 3.39 microns, where gains as high as 23db per meter have been reported, would contribute immediately towards shrinking the size of the loop. The sensor, they assert, can be based upon any of the noble-gas cw transitions.

Use of solid-state cw lasers is not likely in the near future, they claim, although new emphasis on GaAs laser action (M/R, Feb. 4, p. 21) may eventually lead to development of a space-borne solid-state system. These systems require considerable input power—about 2-3 kw—and supporting cryogenic equipment. The Sperry experimental device with a 27mc rf input requires about 50 watts. Furthermore, company engineers note, optical quality is apt to be better in a gas system.

Actually, Sperry contends that use of a dc-excited gas system—as opposed to rf excitation—and use of a ceramic rather than glass would considerably improve environmental tolerances, stability, and noise characteristics.

Sperry reports that beat frequencies in the range of 500 cps to above 150kc have been observed in early tests. This corresponds to respective rotation rates of 2 deg./min. to above 600 deg./min. These are not sensor limitations, as such, the firm says, but merely reflect the early demonstration set-up limitations; actually, sensitivity limits, particularly at the lower frequencies, have not yet been determined.

The high-speed rotation is not expected to pose any problem; however, to bring the present 500-cps level as close as possible to a zero-drift condition will require new effort, primarily directed at improving the stability of the cavity frequency.

Sperry claims the device can also measure angular displacement of a vehicle from a flght path with an accuracy equivalent to 1/15,000 of a degree.

• **Strapped-down system**—In addition to the promise deriving from use of constant-velocity fully-coherent light as the sensing medium, Sperry cites other advantages that should accrue to a refined version of the ring laser sensor.

The sensor is designed as a motionless, strapped-down system attached rigidly to the vehicle frame. Therefore, it has no moving parts, and requires neither bearings, isolation gimbals, or rotors. This removes many critical machining problems associated with more conventional gyros, hence it is viewed as a major gain in economy and reliability.

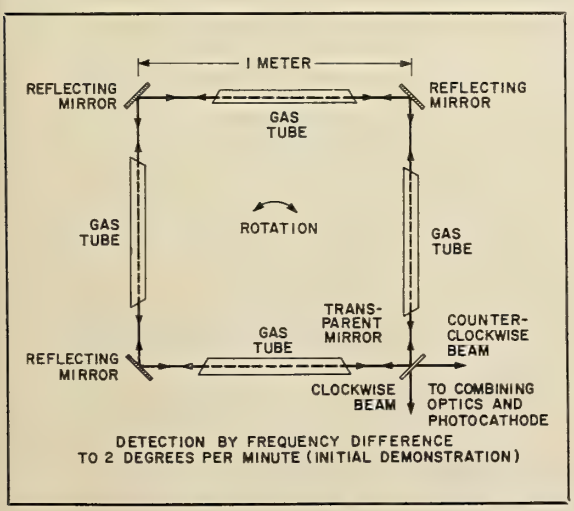
The sensor output is basically digital, and in a form said to be much more adaptable to instantaneous readout than the angular shaft rotation output of a gyro. Since the beat frequency can be easily clipped, differentiated, and counted, the instant readout of angular velocity in cps—and angular displacement in total cycles—are available.

Furthermore, it is claimed that the absence of the rotating mass makes the laser sensor less susceptible to linear acceleration errors—although there is still a problem in stabilizing the reflecting mirrors and associated hardware.

Problem areas will vary according to missions. Available power for space use will certainly require increased input/output efficiencies, since the cw gas laser, as a navigation tool, must operate continuously, possibly long beyond boost phase.

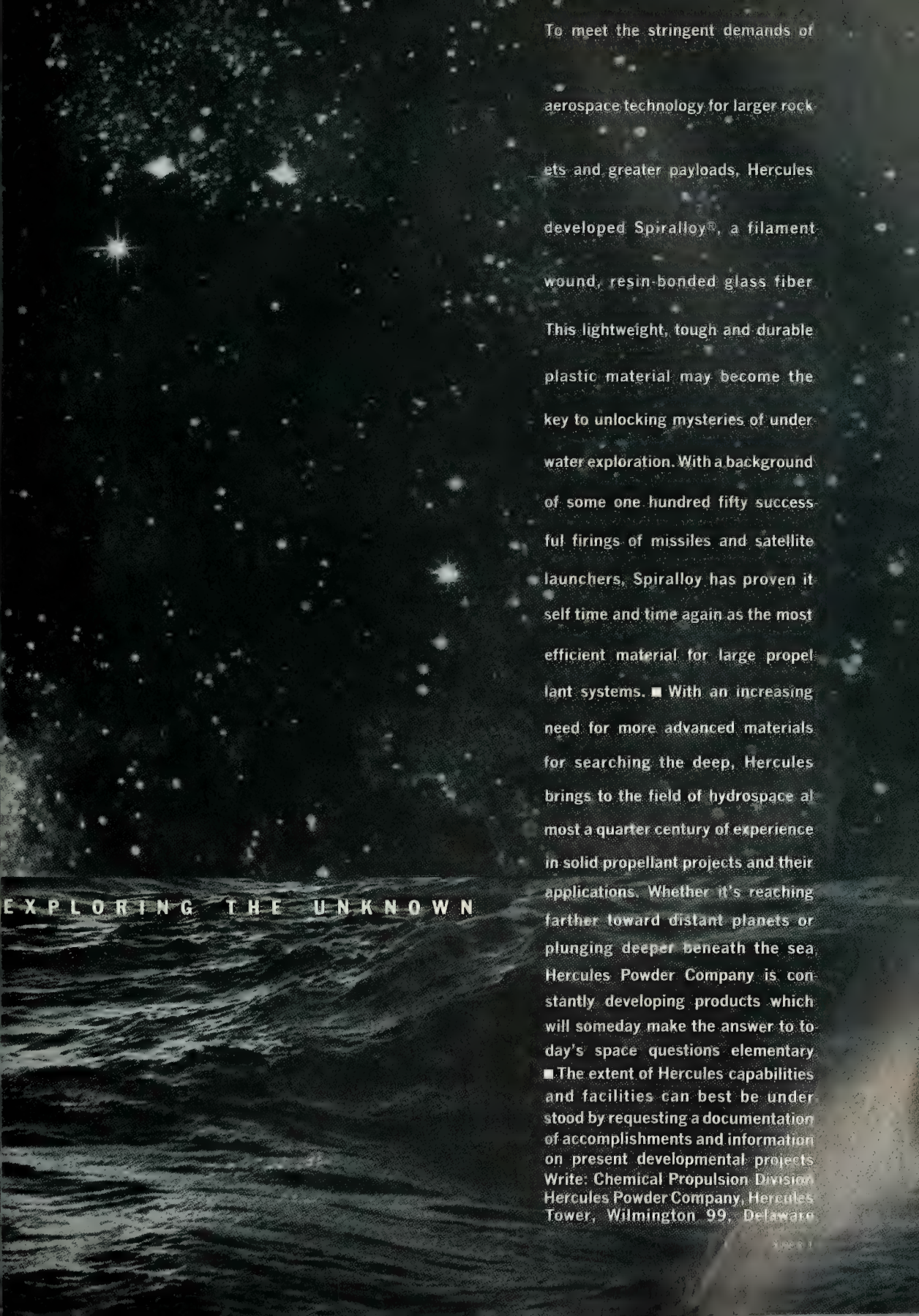
Although relatively simple optics and a standard photodetector tube were used in Sperry's recent experiment, the company reports that improved devices, particularly low-noise photodetectors, will probably have to be developed for systems operating with other gas transitions. There also is a slight possibility that fiber optics may be used in some cases to ease LOS packaging requirements for some ring-lasers.

In addition, Sperry reports it is conducting a continuing study to determine the exact limits of the sensing effect—including the effects of line width, mode pulling, and mode correlation—and is working to develop a suitable means for offset bias, so that a non-rotating system can give a non-zero beat frequency, imparting the ability to tell left from right. ⌗



BASIC DIAGRAM of Sperry's "table-top" rotation rate sensor. Applications effort should improve packaging.


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Cooper To De-pressurize MA-9 Craft

Expanded radiation studies, other experiments planned to test 109 modifications of capsule

by Heather M. David

HOUSTON — Astronaut L. Gordon Cooper may be the first human being to face the real space environment protected only by his pressure suit.

Although he will remain in his *Mercury* capsule, Cooper will use a special lever to de-pressurize his cabin for experimental purposes near the end of his 22-orbit *MA-9* trip, scheduled for the middle of May. The duration of the test and the degree of depressurization will depend upon how Cooper's oxygen supply is holding out. For this reason, he probably will wait until the 17th orbit to make the experiment.

Reportedly, Cooper will have more than enough oxygen to re-pressurize his cabin after such an experiment and still go on for at least 22 orbits. Flight duration may be determined by conditions following the experiment.

Goals of the experiment include gaining confidence in the astronaut's space suit, which has a new helmet design and other modifications; and testing preparatory to *Gemini* flights, which may include as many as four such depressurizations per trip for astronaut egress into space.

In addition to the de-pressurization test, Cooper will be responsible for a number of other tests—some involving manual operation of equipment and others associated with 109 modifications to the capsule.

• **Expanded radiation studies**—NASA hopes to cover the radiation picture from all angles—the nature of the unscattered flux in space; how it interacts with the vehicle, and how much the astronaut receives.

Two geiger counters have been installed on the retro-pack section in hopes of obtaining accurate data on the electron anomaly caused over South America by the high-altitude nuclear test last July.

Information from the geiger counters will be recorded automatically on a tape recorder set to operate one minute out of every 10 during the flight. Also, Cooper will operate the recorder manually during 11 or 12 critical information periods.

Manned flight brings to these measurements an advantage over those of unmanned radiation-detection satellites: the attitude will be known and controlled, according to W. G. Gill, Manned Spacecraft Center Crew Systems Div.

A single film pack will be used inside the cabin to investigate the effect of cabin shielding on radiation; former *Mercury* shots carried four such packs. Cooper will wear four small radiation detectors like those worn by previous astronauts, but the thermo-luminescent coatings will be removed to allow increased sensitivity.

One detector will be mounted on the astronaut's helmet, two on his chest and one on his thigh. Another—to be stored in Cooper's equipment bag, which he will place on the hatch just after boost and take down before reentry—is self-indicating, allowing periodic readings by the astronaut.

• **New medical data**—Space doctors will closely study the extended weightlessness period of *MA-9*. Recently released Russian reports indicate that one of the latest pair of Russian cosmonauts suffered some calcium loss from his bones. This showed up in his urine after about three days of flight. Dr. Stan White believes this loss occurred much sooner than might be expected, judging from bed-rest experience.

Urine will be collected during different periods, allowing doctors to determine the starting time of any condition changes that might occur.

Doctors also will look for orthostatic hypotension, or pooling of blood in the legs, which Walter Schirra experienced for some 24 hours after his flight (M/R Feb. 11, p. 15).

Although the cause of Schirra's blood circulation problem was not pinpointed, NASA doctors believe it was connected with his extended period of weightlessness. But Schirra showed none of the other symptoms—dizziness, heart attack or stroke—usually associated with this condition.

Cooper will perform calibrated exercises—probably in the second and fifth orbits. If time permits, a third session may be scheduled for the eighth orbit.

The astronaut will remain in his chair while doing stretch exercises with a bungee cord at the rate of one stretch (57-ft./lbs.) per second for 30 seconds. Blood pressure and temperature will be recorded before and after the exercise period; heart rate will be monitored continuously. An oral thermometer will be used by an astronaut for the first time in *Mercury* flights.

• **Food evaluation**—The MSC Crew Systems Division will be testing new foods specially applicable to longer flights. Low-residue diet will be maintained, but foods will be dehydrated, requiring addition of water.

Cooper's work-rest cycles and periods of sleep during weightlessness will be observed carefully, but no specific experimental schedules or projects will be designed in this area. Psychologist Dr. Robert Voas believes that the astronaut probably could function satisfactorily without sleep during the flight.

The same tests of balance and equilibrium will be made before and after the flight. Though attempts at more sophisticated versions of such vestibular experiments have been shelved temporarily, they may figure in early *Gemini* flights, Dr. Voas told MISSILES AND ROCKETS.

• **Capsule modification**—About 103 lbs. were taken out of *MA-9*, including an 8-lb. redundant rate-stabilization-and-control system; a transmitter weighing approximately 8 lbs.; a 76-lb. periscope; and a temperature survey, accounting for the rest of the weight.

Equipment added includes a 26-lb. slow-scan television camera. Images recorded by the camera can be transmitted to ground stations, converted to normal-scan signals, taped, and carried over commercial broadcast networks.

The suit temperature problem that plagued astronaut Schirra was traced to dirt which clogged a water-control valve. To handle this, a dual-control capability has been installed. Also, the temperature information gauge has been moved to provide data sooner than in the past system.

The *MA-9* capsule will carry 9 lbs. of water and 5.4 lbs. of lithium hydroxide. Consumables may last 33-34 orbits with minimum usage, officials said.



Hydraulic power package lifts the giant Saturn gantry complex before blastoff

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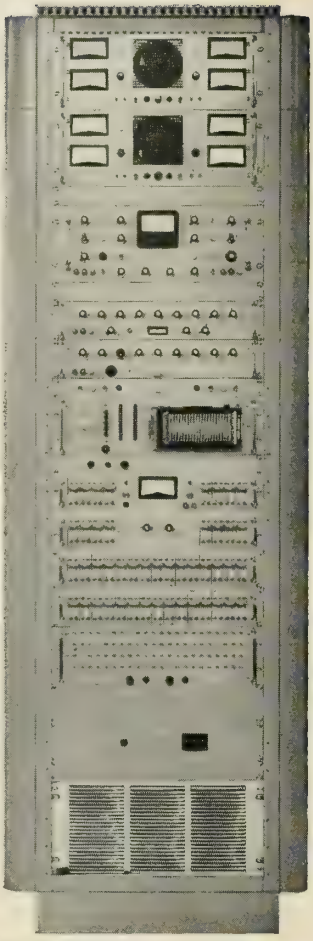
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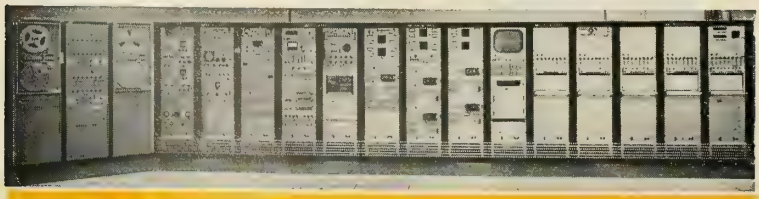
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Other new experiments planned for *MA-9* include:

Zodiacal light photography—A small, 4-lb., 35-mm. Robot camera will be hand-held by the astronaut to photograph zodiacal light. The camera's extremely fast lens—f/0.6—may allow scientists to determine whether the light is caused by reflection on dust clouds; if so, they will attempt to examine the mass distribution of these clouds. Photographs will be taken during the 16th orbit—just after sunset and before sunrise. Light will thus come directly from the Sun rather than being reflected from the Earth.

Air glow studies—The same exposures made in the zodiacal light experiment will be examined for air-glow information. Since the Robot camera has a 50-exposure capability, frames not used for the zodiacal light study may be made available for additional air-glow pictures. In addition, a photometer will be calibrated according to a standard light source mounted on the cabin instrument panel, and then used to measure starlight intensity. These two observations should determine the height, altitude and intensity of the air-glow.

Other photographic studies—The astronaut will employ a hand-held Hasselblad camera, weighing about 14 lbs. and adapted to use 70-mm. film, to snap pictures for two studies— one dealing with optimum definition of the Earth's horizon, the other with spectral reflectance of clouds and land features.

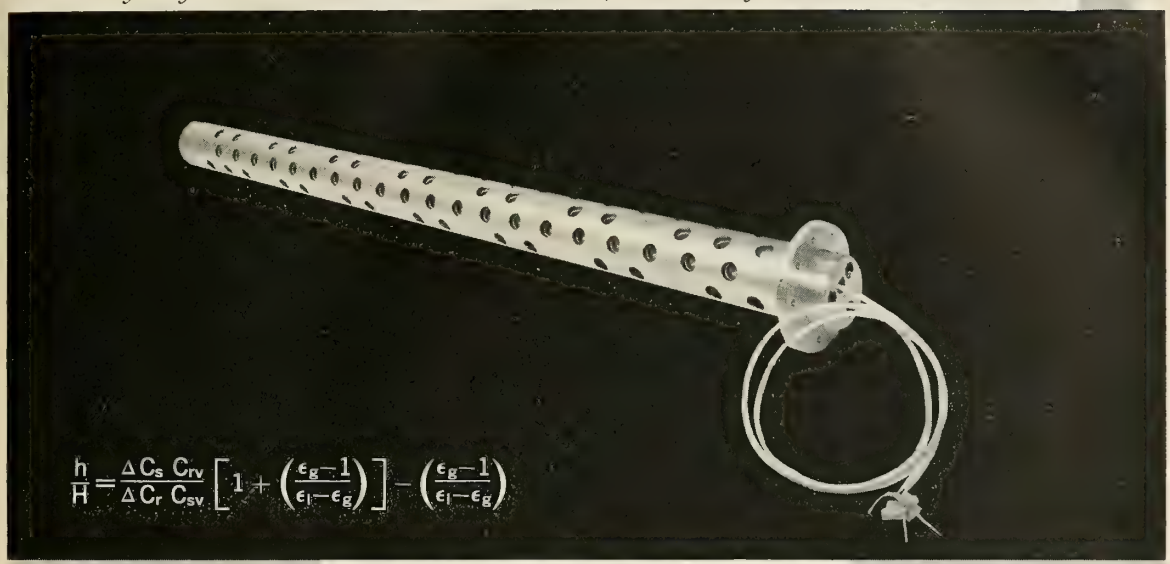
Micrometeoroid impingement—Four shingles, polished to a finish of five micro-inches, will be located on the bottom of the craft to record micrometeoroid impact. They will be microscopically analyzed before and after the flight, as will the spacecraft window.

Deployed flashing light—Visual tracking data on a given light source for rendezvous studies will be obtained by deploying a 5¾"-dia. aluminum sphere with two xenon lights (200,000 lumens each) flashing once each second. A calibrated spring will keep the sphere's velocity away from the spacecraft to 10 fps, and the astronaut will tape his periodic observations of the light source until it is out of sight.

A tethered balloon experiment, repeating the unsuccessful *MA-7* experiment, will be attempted in the sixth orbit. To ensure greater chances of success, the balloon for this flight will be manufactured by an outside contractor, G. T. Schjeldahl Corp., and will consist of a dual sandwich of ¼- and ⅓-mil layers of Mylar, all in day-glow orange. Atmospheric drag will be picked up by a strain gage beam arrangement during the sixth orbit; the balloon will be released during the seventh orbit. ⁂

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END CLOSURE being lifted from curing oven.

space propulsion

UTC To Fire 120-in. Titan III Motor

Single unit tests will be followed by five-segment motor trials in summer

by Robert Lindsey

SUNNYVALE, CALIF.—United Technology Center will test the first 120-in. solid motor for the Air Force *Titan III* (624A) program within the next week.

A single-segment motor with end closures will be fired at UTC's Coyote test facility 25 mi. south of here. Except for some sub-scale components, the 10-by-10-ft. motor will be identical to the building block segments that will make up the solid booster stage for *Titan III*.

UTC plans to follow up the initial firing with one or two more sub-scale tests this spring, then fire the first five-segment motor in mid-summer.

With its two end closures, the single-segment motor is expected to generate approximately 250,000 lbs.-thrust for about 120 sec. Gross weight will be about 50 tons.

Fired nose-down, the motor will be instrumented at some 200 checkpoints to give UTC engineers their first data on the interaction of a 120-in. charge with components under development.

UTC officials are surprisingly confident about results of the test program. In explaining their optimism, they stress that the propellant and virtually all components of the *Titan III* motor have been tried and proven. The only job remaining is to integrate and optimize the design in an operational system.

Company officials told MISSILES AND ROCKETS that since last spring when UTC was selected to develop the 120-in. motors, and DOD finalized the design in its lengthy *Titan III* program-definition phase last fall, these steps have been taken:

—Component design has advanced far enough so that very little change is expected as the program progresses.

—A comprehensive program plan detailing development goals and schedules several years into the future has been prepared and adopted.

—Negotiations have been completed with nearly all major subcontractors.

—Without waiting for subcontractors to be chosen, UTC designed and acquired prototype hardware to permit testing of the first motor only three months after DOD authorized the program.

—Construction is well advanced on new static test and processing facilities at Coyote and engineering facilities in Sunnyvale.

—A new organization was established within UTC to conduct the *Titan III* program.

—PERT II Cost/Time techniques have been adapted to the program.

• **Streamlined management**—UTC took two steps to insure that the program had direct lines to top management and that it was unfettered by other programs:

1) UTC President Barnet Adelman took reins as director of the *Titan III* program and Dr. David Altman, vice president-research, was named assistant director.

2) The company created a new organization—the Space Booster Div.—specifically for the *Titan III* effort. It is divorced from the company's other solid-motor research and development activities.

Directly under Adelman and Altman is the *Titan III* program management office, headed by Willen Schaafsma. A group of line divisions under Schaafsma has responsibility for motor development, thrust-vector-control system development, vehicle integration, field testing, manufacturing and logistics, and personnel subsystems.

UTC has about 900 persons working on the program and it expects the

number to increase to about 1500 by fall.

High in the *Titan III* command structure is the PERT II Cost/Time program staff. This management team's technique, being used for the first time in the *Titan III* program, coordinates cost and schedule considerations.

Adelman says he is pleased with progress of the project so far. "We've brought together the various facets of the program and put them in engineering terms that could be described as a definite program."

• **Reliability chief goal** — "Perhaps the key element of this program is that it is not seeking to advance the state of the art. It is designed for maximum reliability. We know it will work. The basic designs were arrived at a year ago or more.

"We have accomplished tests on all major components of the system and they have performed satisfactorily. We've run six tests (on big solid motors) and they've all contained some of the components of this system. It's given us a head start."

Propellant formulation, for example, he says, has been firm for "roughly two years" and millions of pounds have been made. This experience yields a propellant with thrust-level variations of "something less than 1%" from batch to batch, Adelman says.

(The Air Force has stipulated that no more than 1% thrust variation can be permitted in pairs of the 120-in. motors.)

Adelman claims UTC will produce no hardware for the booster. "About 50% of the total 120-in. funding will be farmed out."

UTC regards its role in the solid-motor program as five-fold management of the total effort: motor design, propellant manufacture, quality assurance over the whole project, integration and testing.

The first two major subcontracts have been awarded—one to Curtiss-Wright and one to Westinghouse's Astronuclear Laboratory and steam divisions—for parallel programs to fabricate the 120-in. motor casings. Presumably, one will be chosen later as the only source.

• **Early testing**—Altman says that long before bids were sought from subcontractors to the *Titan III* program, the company contracted for hardware so it could conduct motor tests early. "It was an anticipatory gamble but we were able to acquire hardware within six months to provide an early start on the program."

The hardware for the test this month was supplied by Willamette Iron & Steel Co., case; H. I. Thompson Co., nozzle; and Hamilton Standard thrust-vector-control injection valves.



WORKMAN PLACES blocks under motor segment after UTC's proprietary loading process is completed. With both closures, total weight of motor reaches 50 tons.

Although details are classified, the total test program is believed to encompass 15 to 20 firings before the first flight test. The test program has four phases:

—Development tests in which to prove out basic component design. This phase may include one or two more single-segment motors as well as full five-segment motors.

—Preliminary Flight Rating Test (PFRT) firings to demonstrate TVC, total impulse, thrust termination under emergency conditions, destruct characteristics and other performance characteristics under varied conditions. This is the first phase of the test program where failure to meet specifications subjects UTC to penalty under the *Titan III* cost-plus-incentive-fee contract.

—Initial flight tests managed by Martin Co., *Titan III* system integrator.

—A qualifying program to demonstrate the motor's capability, as one engineer put it, "in smaller brush strokes." The motors must yield specific impulse with lower tolerances permitted. The final two phases of the test program will be roughly parallel.

Although UTC officials refuse to discuss detailed specifications of the motor, certain observations can be made from previous Air Force/industry comments:

—The propellant is apparently an advanced rubber-based polybutadiene acrylonitrile fuel with aluminum additives and ammonium perchlorate oxidizer. The composition is about 70% oxidizer and 30% fuel. Chemical additives control burning rate.

—Specific impulse is probably about 245 sec.

—Mass ratio will be about 0.88.

—The propellant core is circular to minimize stresses and is about four feet in diameter, leaving a propellant web of about 36 in. The motor shape is cylindrical.

—Thrust-vector-control system will probably use nitrogen tetroxide injected through a series of ports.

—One igniter will be used, and this a small rocket.

—The nozzle will be fabricated of segmented graphite covered by a steel outer jacket. The nozzle will be canted outboard six degrees to minimize effects of thrust variations from motor-to-motor TVC requirements.

—The motor casing will be rolled and welded steel and will use clevis-type joints at each segment.

—Thrust termination will be achieved by opening of forward ports.

• **Engineering aspects**—Schaafsma, the project manager, echoed Adelman's views that there are no major engineer-

ing problem areas:

"This is probably the most pre-engineered rocket motor development in the history of rocketry. We don't look at any of the component areas as problem areas. Almost all components are state of the art."

Asked if DOD's extended *Titan III* program-definition phase had speeded up the UTC development program, Schaafsma said:

"A lot of very useful engineering work was accomplished. I think it gave us a firmer foundation with regard to overall missile design. Whether we saved any time in the motor development program is questionable, but there were very few unknowns when the program was finally given the go ahead."

Although UTC officials said TVC isn't a major problem, they believe it will probably require more work than other areas, at least during initial phases of the program.

Altman says a UTC-designed fluid injection TVC system used in Air Force-funded firings of 100-in. motors "exceeded the requirements for *Titan III.*" This design will be used in the program. "It has the capability; now we have to design for reliability."

Ignition of the motors poses no real development problems, Altman said. Laser and hypergolic ignition systems were considered, but they had not been tested sufficiently at the time of commitment to be incorporated into the program with the same confidence as the other components. Since the two *Titan III* motors must be ignited simultaneously, this adds a new dimension to the ignition problem, notes Altman, "but we have fired clustered motors with excellent results."

• **Nozzle problem whipped**—Nozzle design, another problem which seemed big a year ago, isn't a problem now. Nozzles used successfully in the UTC 100-in. motors can be scaled up without difficulty according to Altman.

Altman points to the basic engineering problem as achieving reliability —a point particularly critical because *Titan III* must be man-rated. But he says it's not a major problem area. "It is more a question of instrumentation to prove reliability rather than a question of fundamental capability."

The Air Force has dictated the system must incorporate "immediate and effective thrust termination" in case of potential hazard to crewmen. Schaafsma says considerable data has been gathered to identify clues that warn of trouble brewing in big solid boosters, and this research will be stressed during the PFRT phase.

"It's not as easy to do in a solid as it is in a liquid, but we believe we can put in a system that is quite safe," he says. Heart of the malfunction detection will probably be over-pressure sensors.

UTC will conduct most tests in the program at Edwards AFB, where the Air Force is currently building an $8-million solid-motor test complex. However, the company is erecting its own new test bay at the 5200-acre Coyote facility. Construction is virtually completed and the facility is being instrumented now.

The stand is capable of handling motors generating more than 4 million-lbs. thrust. The single-segment firing this month will be in a UTC test bay capable of handling thrusts up to 2 million lbs.

Both stands will be served by the same blockhouse. The big bay will be also served by a new unmanned instrumentation building that automatically controls tests, including programmed TVC fluid injection. A one-foot aperture at the top of the new test stand will feed fluid to the motors from a TVC flow facility adjacent to the peak of the bay.

Most details of how the *Titan III* motors will be made are secret, either for security or proprietary reasons, but Eugene Roberts, operations director, outlined the basic plan.

• **Production Flow**—After delivery to the processing area of the Coyote facility, motor casings will be inspected for meeting strength specifications. Next the casings will be insulated. A preformed rubber sheet in tubular layers will be bonded to the casing with an epoxy adhesive. After it has dried it will be inspected with ultrasonic and black light devices to check the bond.

A polybutadiene liner will be sprayed or spun around the rubber insulation and cured overnight. Meanwhile, fuel, oxidizer and additives are vacuum-blended in a vertical mixer to prevent introduction of bubbles.

After each propellant batch is mixed, technicians will assay a 2-lb. sample. Each sample will be subjected to seven tests UTC has developed to insure identical quality between batches. The principal tests examine the propellant's burning rate, curing characteristics, energy level and chemical analysis.

If the assay proves the propellant up to quality, it is poured into the motor casings, also under a vacuum. Roberts said UTC has developed a proprietary curing technique reported to be more efficient and cheaper than the conventional method.

After the cure is complete, the mandrel is removed and the motor is visually inspected. Roberts says conventional quality assurance techniques are considered more than adequate.

Roberts says UTC's relatively long experience with the *Titan III* propellant formulation gives the company high confidence in it. He notes the major pitfalls in producing reliable solid motors include faulty propellant mixture, bubbles, cracks and faulty bonding. All these can be prevented or detected by rigid manufacturing controls and extensive screening during manufacturing, he says.

"Not only do we make physical and chemical tests of everything going into the propellant before processing, but tests are made during the processing to learn if it meets many specifications we have established with long experience. We have an extensive program to minimize stresses on the motor; for example, to avoid excessive strains on the propellant, it is cooled down at a controlled rate to keep temperature gradient across the charge within specified limits."

UTC expects no problem in meeting Air Force requirements to demonstrate that the motors can be stored for long durations under varying temperatures. Roberts says the company has had a 100-in. cylindrical motor stored for more than two years and it has shown "virtually no degradation."

The motors will be trucked via specially built transporter from the Coyote Mountain processing plant to a nearby rail siding, then put aboard a train for Cape Canaveral. Early motors will go by rail to Edwards AFB. ⌘



SEGMENT motor case is shown before loading. Clevis pin holes for segment mating are barely visible around foreground periphery of the rolled and welded case.

AEC Sees Off-the-Shelf Space-Power Packages

by William Beller

THE ATOMIC ENERGY COMMISSION wants to become a supermarket in the nuclear space-power field.

When customers come in, the agency would like to give them a choice of nuclear powerplants in a wide range of sizes and shapes.

They would be built on a modular basis. If a buyer wanted 750 kw, for instance, he might be sold an augmented 500-kw system.

• **Modules under development—** The building-block concept already is being used on one space nuclear-power project under joint development by AEC and NASA. It's presumed that SNAP-8, designed to produce 30 electrical kw with one rotating conversion unit, will be able, with addition of a second rotating unit, to put out 60 kw.

Simply by changing SNAP-8's operating conditions, the AEC hopes to be able to devise individual powerplants rated anywhere in the band starting below 30 kw and ending above 60 kw. In this manner, the commission conceivably could create a spectrum of powerplants that by the mid-1970's might stretch from a few watts output to beyond one megawatt.

"Off-the-shelf powerplants—that's what we'd have," Nelson Sievering, AEC's associate director for advanced systems, told MISSILES AND ROCKETS last week. "We'd be a service organization in the nuclear space-power field." Sievering warned, however, that the modular idea is still in the "looking into" stage.

• **Nuclear power available now—** Sievering said that agencies needing space-power should factor nuclear power into all their thinking and plans. For example, he said, "isotopes should be employed more—the user agencies should be telling us what they want and when they want it. For many relatively low-power jobs, we can satisfy them now."

Sievering hastened to add that he is not complaining: the isotopic units for *Transit* satellites certainly show that people want AEC space products. He said his criticisms were akin to those of a parent seeking better consideration for his offspring. Besides, he indicated, there is no other child to do the required space work.

• **Families of technologies—** "You can't afford to change powerplant concepts with each new space mission," Sievering said, "nor would the user—from a time and cost viewpoint—want to develop new concepts." He urged that current nuclear space-power projects be looked upon simply as representative of families of technologies—not as discrete developments of power.

Thus, if the spectrum-of-power concept is feasible, it must be supported by such families. The AEC has already started:

—Isotopic technology, from microwatts to 500 watts. SNAP-3 (2.7 watts) is operational in *Transits 4A* and *4B;* SNAP-9A (25 watts)—the first isotopic generator specifically designed for a space mission—has already been ground-tested. SNAP-11 is under development for the *Surveyor* soft-lunar-impact probe.

—Uranium-zirconium hydride technology, from 500 watts to 100 kw. The reactor fuel concept was developed in SNAP-2 (3 kw), the initial SNAP reactor program. The 500-watt SNAP-10A—scheduled for flight-testing this year—and SNAP-8 use essentially the same fuel technology as SNAP-2. SNAP-2 is scheduled for flight-test in 1965, and SNAP-8 possibly in 1966.

—Boiling potassium technology, an Oak Ridge National Laboratory development in the 100-kw to 300-kw range.

—Lithium technology, from 300 kw to 1 mw. SNAP-50/SPUR, a lithium-cooled fast reactor, is expected to be incorporated into a system by the late 1960's or early 1970's. This includes not only reactor development but also development of the power-conversion unit and radiator. With a specific weight of 10 lb/kwe unshielded, the system will be designed to produce 300 to 1000 kwe for 10,000 hours of unattended operation.

"It will be possible to extend the power level for (the lithium) technology to at least one megawatt by the mid-1970's," AEC chairman Glenn T. Seaborg told the Atomic Industrial Forum late last year, "and we expect the same reactor technology to make possible thermionic systems of even greater power beyond 1975."

• **A hard look at SNAP—** Before the modular concept becomes policy, the AEC has to answer one basic question—what is the market for nuclear power for space? To help get the answer, Seaborg recently set up a study group under AEC Commissioner Leland J. Haworth to take a new and hard look at the entire SNAP program (M/R, Dec. 10, p. 21). Sievering said the report "will not be out before this summer."

To find the required data, the AEC team earlier this month began getting industry briefings. The team will receive subsequent briefings from user agencies—the military, NASA and the Communications Satellite Corp.

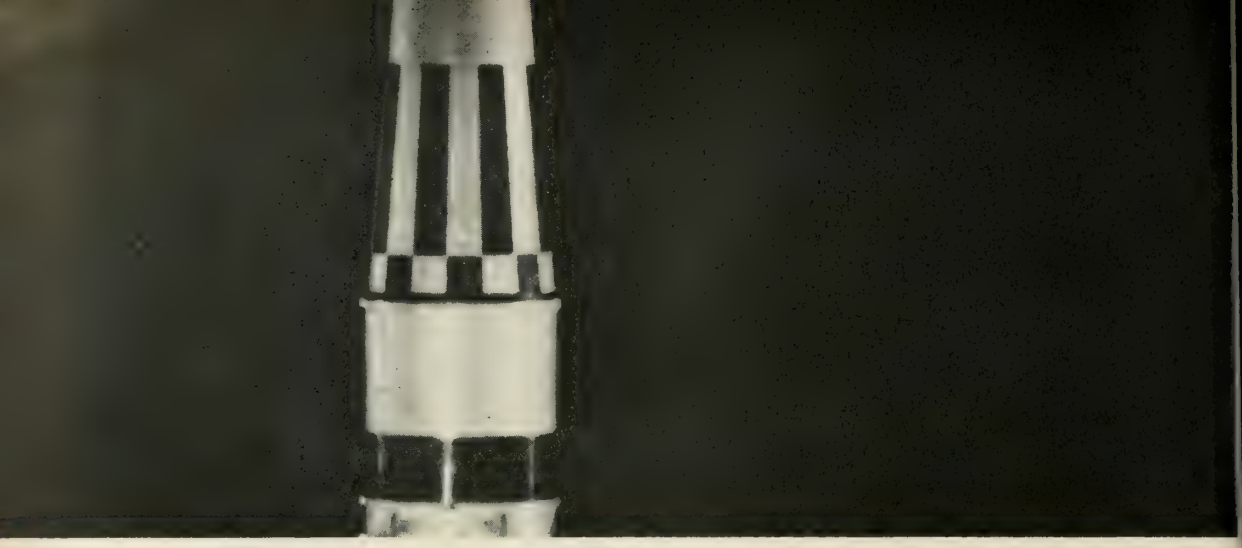
Some of the information sought: What power levels are needed? What kind of power in cps? What kind of vehicle will be using the power? The answer to the last question will help describe the powerplant envelope.

The modular concept for power development will be seriously considered, said Sievering. "If a user needs power in the SNAP-50/SPUR range, what penalties would he have to pay to deviate from the design power?" Maybe it won't be feasible to downgrade powerplants, Sievering argued, speaking in the role of devil's advocate. "Still, if we had 3 kw today, there'd be a user," he said. "Even if he wanted 12 kw he'd be delighted with 3 kw—even if it weren't optimum design."

Sievering observed that a spectrum of power would add flexibility to space missions, because the power requirement for the same space mission grows with time as the mission gains in sophistication. "What takes 3 kw today will take 12 kw tomorrow," he said.

• **Modular concept questioned—** Harold Finger, on the other hand, told M/R that "every time you make a power change in a nuclear system, it's a major change." For this reason Finger—director of NASA's nuclear systems—has strong doubts that the modular system for developing a power spectrum will work. "New problems always come up: reliability, control integration and system operation." He pointed out, as an example, that when two power-conversion systems are used in parallel, flow problems always arise—and often lead to instability.

If the Haworth report nevertheless supports the modular concept, the AEC will propose selling space nuclear-power on a building-block basis to all certified buyers—on terms of cash or fiscal-year credit. ⌗



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The Industry Week

SBA Role Sought in ComSat

A bill being considered by the Senate Committee on Science and Astronautics would give the Small Business Administration a say in procurement affairs of the Communications Satellite Corp. Goal of the bill is to ensure for small businesses a reasonable opportunity to compete directly or as subcontractors for procurement orders from the ComSat group.

The measure (S 233) also would allow the SBA to obtain from the Communications Satellite Corp. and from communication common carriers pertinent information concerning procurements and contracts awarded in implementing the ComSat program.

Senators John Sparkman (D-Ala.), Mike Mansfield (D-Mont.) and John Pastore (D-R.I.) introduced the bill.

Industry Facilities

Varian Associates is constructing a new $1 million facility for its Central Research Laboratory. The 43,000-sq.-ft. building and associated parking space will occupy a five-acre site near the firm's administration building in Palo Alto, Calif. The facility is expected to be ready for occupancy by the end of the year. It will consist of a two-story laboratory wing, a technical library and administration and reception area. About 50 scientists and 100 technicians and other support personnel will be housed in the new building. . . . *Another $1 million is being spent by General Precision Inc.'s Aerospace Group on construction of a Wayne Township, N.J., facility to house one of the group's four operating divisions, the Aeorspace Systems Div. The two-story, 108,000-sq.-ft. building, expected to be completed early in 1964, will house more than 700 scientists and other personnel. It will be the first of several specially designed buildings planned for a 113-acre tract recently acquired by GPI.* . . . Union Carbide Corp.'s Linde Co. says it will have the nation's largest liquid hydrogen plant by next January. The firm has arranged for construction of the 60-ton-per-day plant on a 56-acre site near Sacramento, Calif. Construction, to begin this month, is expected to cost $15 million. The facility is being built under a seven-year $85-million liquid-hydrogen-supply contract Linde holds with the National Aeronautics and Space Administration. . . . *Precision annealing facilities have been installed at the new Prentiss Plant of the Riverside-Alloy Div. of H. K. Porter Co., Inc. The new controlled-atmosphere furnaces will assure constant temper on all wire produced at the Holyoke, Mass., plant, the firm reports.* . . . American Micro Devices, Inc., is moving its Standard Rectifier Div. from Santa Ana, Calif., to Phoenix, Ariz., where newly expanded facilities are ready to accommodate the division. Operations of the unit will be resumed Mar. 1, and additional personnel will be hired at that time.

New Firms & Divisions

Rosae, Inc., a research, engineering and consulting firm, has been formed at Eau Gallie, Fla., by W. H. Grisham, formerly an advanced planner for the Air Force Atlantic Missile Test Center. The firm will focus its activities on satellite communication systems, and it is preparing patent applications for several concepts in this area. . . . *J. E. Lay and H. K. Welsh, formerly associated with Tube Distributors, Inc., have formed their own firm, Mondus Steel Service Corp. The new firm will distribute a complete line of steel and aluminum products suited to military specifications as well as other commercial applications. The company, which has set up offices in the Empire State Building, maintains that a great number of producers tend to concentrate on a particular specification item, so that there are few central sources of an extensive and varied line of specification materials. The founders of the firm hope to establish a single source for such a complete line of these materials.* . . . Radio Corp. of America's Electron Tube Div. has set up a new department responsible for direct energy conversion devices and related products. The department will direct and integrate programs of the division related to: thermionic energy converters; thermoelectric materials and devices for power generation, as well as for cooling; solar cells; and superconducting materials and devices. . . . *International Telephone and Telegraph Corp. has set up a new ITT Electron Tube Div. to be responsible for all phases of ITT's domestic special-purpose tube business. The division will be housed in a new $3.5 million, 125,000-sq.-ft. plant to be built this year near Easton, Pa.* . . . ESC Electronics Corp., New Jersey producer of custom delay lines for missiles, ground-support equipment and computors, has established a new filter division. The company supplied prototype filter units for certain missile/space and communication applications during 1962. It plans to expand its activities into this area, including filter production, in the near future. ESC's products are on many missiles in development and production, such as *Nike-Zeus, Terrier, Bullpup, Sidewinder,* etc. . . . *Video Color Corp., Inglewood, Calif., has set up Vidcor Components Div. as its component manufacturing unit. The division will manufacture devices formerly produced under the VCC label, and it will design and manufacture such custom components as inductive devices, delay lines and pulse transformers.* . . . Lear Siegler Inc.'s subsidiary, Trion Instruments, Inc., Ann Arbor, Mich., has been renamed the LSI Laser Systems Center, as another step in LSI's policy of identifying various company units by their products and programs. Trion became part of LSI in mid-1962.

AWARDS

AIR FORCE

$18,200,000—**North American Aviation, Inc.,** El Segundo, Calif., for continued research and development on *Minuteman* guidance systems (2 contracts). Work to be done at Anaheim, Calif.

$11,193,951—**Boeing Co.,** Seattle, Wash., for fixed assembly and checkout of equipment for *Minuteman* sites. Work to be done at Malmstrom Air Force Base, Mont.

$6,000,000—**International Electronic Corp.,** Paramus, N. J., for fabrication and delivery of electronic equipment.

$6,000,000—**Ryan Aeronautical Co.,** San Diego, Calif., for continued production of more than 150 Q-2C *Firebee* free-flying jet target missiles for the Air Force and Navy.

$5,735,000—**Avco Corp.,** New York City, for work on re-entry vehicles (supplemental contract). Work to be done at Stratford, Conn.

$5,605,000—**Sperry Gyroscope Div., Sperry Rand Corp.,** Great Neck, N.Y., for missile-tracking vessel work.

$5,409,566—**Anaconda Wire and Cable Co.,** Hastings-on-Hudson, N.Y., for production of intersite cable for *Minuteman* sites at Ellsworth Air Force Base, S.D. Work to be done at Cambridge, Mass.

$5,298,525—**Aerospace Corp.,** El Segundo, Calif., for work on space programs.

$4,130,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for procurement of long-lead-time items for *Agena* boosters and for procurement of ground support equipment for F-104G aircraft.

$4,000,000—**General Motors Corp.,** Detroit, for research and development for the *Titan II* guidance system.

$4,000,000—**General Precision, Inc.,** Little Falls, N.J., for conducting a flight feasibility test program for a steller inertial guidance system.

$3,541,000—**Lockheed Aircraft Corp.,** Burbank, for provision of launch services capability on the Pacific Missile Range.

$2,193,247—**General Electric Co.,** New York City, for the performance of services for test operations in support of the Pacific Missile Range. Work to be done at Syracuse, N.Y.

$2,055,483—**Telemetrics, Inc.,** Gardena, Calif., for provision of time division multiplex systems and related material.

$1,822,500—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for launch support of military and NASA space programs. Work to be done at Vandenberg Air Force Base, Calif.

$1,782,104—**Anaconda Wire and Cable Co.,** Hastings-on-Hudson, N.Y., for intersite cable for Whiteman Air Force Base, Mo., *Minuteman* sites.

$1,560,000—**Space General Corp.,** El Monte, Calif., for research, development, test and engineering for a low-frequency communication system.

$1,521,467—**Radio Corp. of America,** New York City, for *X-20 (Dyna-Soar)* space glider work.

$1,500,000 — **Sylvania Electric Products, Inc.,** Mountain View, Calif., for design, development and production of electronic security systems for the *Minuteman* program.

$1,480,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, for work on the *X-20 (Dyna-Soar)* primary guidance system. Work to be done at St. Petersburg, Fla.

$1,100,000—**General Electric Co.,** New York City, for Atlantic Missile Range work.

$1,000,000—**Philco Corp., Western Development Laboratories,** Palo Alto, Calif., for work on control subsystems for space systems.

$1,000,000—**General Dynamics Corp.,** New York City, for production of equipment, spare parts, tools and test equipment for installation and checkout of *Atlas* missiles. Work to be done in San Diego, Calif.

$483,000—**Martin Co.'s Denver Div.,** for development of the manufacturing methods, processes and related design data to fabricate an expendable space structure.

$340,000—**United Aircraft Corp., Hamilton Standard Div.,** Windsor Locks, Conn., for studies involving the use of electron beams for welding in space.

ARMY

$4,600,000—**General Time Corp., Westclox Div.,** La Salle, Ill., for production of mechanical time fuzes.

$3,752,791—**Chaney & Jones Construction Co.,** Dallas, for construction of F-1 engine test facility at Marshall Space Flight Center.

$1,600,000—**General Dynamics/Pomona,** Pomona, Calif., for continued development of *Redeye* missile system.

$1,523,808—**Curtiss-Wright Corp.,** Wood-Ridge, N.J., for *Pershing* missile motor cases.

$1,400,000—**Walter Kidde & Co.,** Belleville, N.J., for solid propellant JATO-type drone target motors.

NAVY

$22,606,463—**Sperry Gyroscope Div., Sperry Rand Corp.,** Great Neck, N.Y., for missile radar sets.

$11,640,545—**Hughes Aircraft Co.,** El Segundo, Calif., for *Polaris* fire-control systems.

$6,015,442—**Martin Marietta Corp.'s Orlando Div.,** Fla., for additional funds for conversion of a letter contract for *Bullpup* missiles.

$1,234,549—**Vitro Corp. of America,** Silver Spring, Md., for continued engineering and supporting services for *Terrier* and *Tartar* missile systems, and for development, organization and implementation of a Change Control program for surface missile system.

NASA

$15,029,420—**Raytheon Co., Space - Information Systems Div.,** Sudbury, Mass., for *Apollo* command module on-board digital computer, test set, simulator, and calibration equipment.

$6,000,000—**USAF Space Systems Div.,** Inglewood Calif., for *Gemini Titan II* launch vehicle (supplemental contract).

$350,000—**Massachusetts Institute of Technology,** Cambridge, for continued work on Project *Apollo.*

$287,200—**Control Data Corp.,** Minneapolis, for high-speed digital data processing equipment for PACE system at Cape Canaveral.

$136,640—**Republic Aviation Corp.,** Farmingdale, N.Y., for studies of overall system requirements for the Synchronous Meteorological Satellite (SMS).

$131,424—**Bissett Berman Corp.,** Santa Monica, Calif., for conducting systems engineering studies for the manned lunar program.

Northrop Corp., Needham Heights, Mass., for production of a gimballed tracking mount to support a 3500-lb. telescope system (undisclosed amount).

INDUSTRY

$7,300,000—**Royal Industries, Inc.,** Los Angeles, from **General Electric Co.** and others, for classified work.

$2,000,000—**Meg Products Div., Mandrel Industries, Inc.,** Seattle, from the **Boeing Co.,** for fabrication of cable assemblies.

$693,000—**Canoga Electronics Corp.,** Van Nuys, Calif., from **Melabs,** for electronic reconnaissance antenna systems.

$600,000—**Garrett Corp., AiResearch Manufacturing Div.,** Phoenix, Ariz., from the **Martin Co.,** for small gas turbine engines to power the *Pershing* missile system.

$505,000—**Fairchild Stratos Corp.,** Hagerstown, Md., from **Nouveaux Ateliers Lebrun, S.A.,** for components for the NATO *Hawk* missile program.

$500,000—**Space Corp.,** Garland, Tex., from the **Boeing Co.,** for the manufacture of mobile maintenance and support equipment for the *Minuteman* program.

$413,000—**Raytheon Co.,** Mountain View, Calif., from **Melpar, Inc.,** for ultra-reliable transistors for the *Minuteman* missile.

$150,000—**American Machine & Foundry Co.,** Stamford, Conn., from the **Boeing Co.,** for development and testing of *Minuteman* blast valves.

Daystrom, Inc., Weston Instruments and Electronics Div., Newark, N.J., from the **Boeing Co.,** for development of a small, lightweight skin temperature readout for the *X-20 (Dyna-Soar)* (undisclosed amount).

Rucker Co., Oakland, Calif., from the **Sandia Corp.,** for design and manufacture of what will be the free world's largest dynamic capacity acceleration test machine (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Study contract to determine optical configuration of high efficiency, high resolution in telescope, spectrometer and photometer system, for use on *Orbiting Astronomical Observatory.* Job—RFP A-67-43. RFP due date 2-25-63.

National Aeronautics and Space Administration
Chief, *Mercury* Procurement
Manned Spacecraft Center
Houston, Tex.

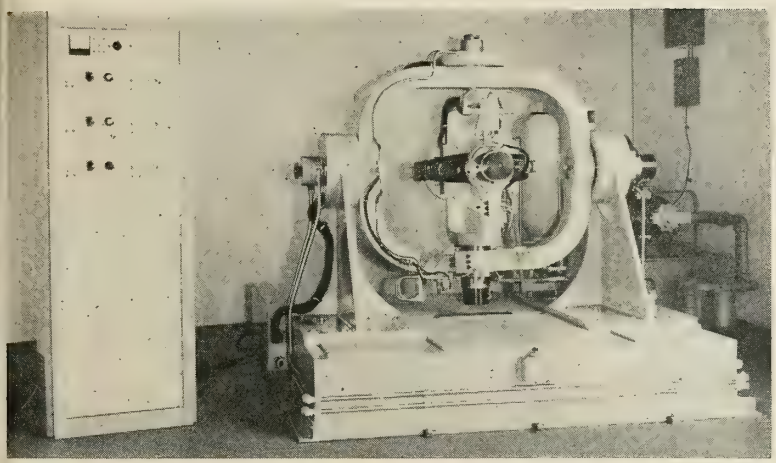
Negotiations will be conducted with B. F. Goodrich Co., Akron, Ohio, for *Mercury* space suit helmet assemblies. For information only. No RFP available.

Procurement Directorate
Air Force Special Weapons Center
Kirtland Air Force Base, N.M.
Attn: Base Procurement Div.

Solid state frequency changer—1 each. Delivery to transportation officer, Bldg. 1015, Kirtland Air Force Base, N.M. IFB 29-601-163. Bid opening 3-18-63.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Visual landing attachment for manned flight simulator to provide visual scene around airstrip under various lighting conditions. Three dimensional and colored to operate with government analog computer. One system. RFP A-6747; due date 2-25-63. Copies of IFB will be furnished to the extent available on a first received, first served basis.



New Product of the Week:

Three-Axis Flight Simulator

Developed by Carco Electronics, Model S-450A three-axis flight simulator provides extended low-velocity operation, unequaled dynamic range, large load capabilities and is available in space and Earth coordinates.

The flight simulator is programmed by an analog computer or a function generator to duplicate the angular rotational motions of an actual missile, space capsule or aircraft. It provides, for laboratory and quality assurance purposes, a highly precise prediction of the accuracy and stability of the guidance and control equipment when in actual flight. With maximum rates in excess of 700 degrees per second and minimum rates of less than one-tenth the Earth's rotational rate, this equipment has a controlled dynamic velocity ratio of more than 1,750,000 to 1. High angular controlled accelerations exceed 50,000 degrees per second squared, with a frequency response of more than 27 cycles per second with rated load.

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Gas Laser

A precision gas-laser-producing continuous-wave coherent light has been developed by Optics Technology, Inc.

The Model 150 produces visible light at 6328 angstroms, and accessories are available for infrared output at 1.153 microns.

The laser is used as a source for modulation and long-path interferometer experiments, demonstrations in classical optics and various systems applications. Its precision mirrors adjust to produce various mode patterns.

Circle No. 226 on Subscriber Service Card

X-Band Amplifiers

Four all-solid-state x-band multipliers for a wide range of system applications in the 7.6 through 11.5 gc frequency area have been introduced by Microwave Associates, Inc. The devices feature all passive harmonic generation by means of silicon varactor diodes and develop power outputs in the range of 10 mw to 150 mw.

Typical of the units is the MA-8107 multiplier, which generates microwave signals of moderate power in the upper half of x-band. The package contains four stages of frequency multiplication with a fixed-tuned output of 1% bandwidth. The unit requires no d-c power since the input RF power provides the total necessary excitation.

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Metal Glaze Resistor

A 2-watt metal glaze film resistor with an average load life change of 1% is available from International Resistance Co.

Dielectric strength of the IRC non-inductive resistor is more than 1000v rms, and it will withstand short-time overloads of 10 times the rated wattage for five seconds, with an average change of less than 0.25%.

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Why selecting a scientific or engineering computer without a feasibility study can be a costly error

And the one sure way to find the computer that suits you best

A scientific or engineering computer is a sizeable investment. Selecting one calls for a responsible decision. Far from being alike, computers vary in efficiency and in ways they can be used. They vary, too, in price—and the equipment price tag doesn't always reflect **true cost.**

Your selection, then, should be based upon a careful study. Concentrate not on details, but on finding the one computer that will best suit your firm's particular needs. You may find your answer in the Recomp® line of solid-state computers, as so many companies have. But two important considerations—**total** problem-solving time and **total** cost—best measure a computer's worth.

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The criterion to use is total problem-solving time. On the average, computing time represents only about 10% of the time required for complete solution of an engineering or scientific problem. Microseconds saved in computing mean nothing if hours are lost in programming, which often is 90% of the total job.

The Recomp line of small and medium-scale computers save programming **hours,** not just computing **microseconds.** They are simple to program, easy to operate, and have exceptionally large memories.

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Scientific problem-solving computers sell from $40,000 and up; rent from $1,000 a month, and up. But in comparing price, remember: 1) Cost figures should cover the **entire working system** needed to accomplish a job. 2) "Man hours" saved are an important facet of cost. A company which once got 2 proposals a year from a top creative scientist increased this to 3½ with a computer (not Recomp). With Recomp, the company now gets 9 proposals per man a year.

Recomp offers a broad price range. The Recomp III, ideal for small-scale needs, can be leased for $1,495 per month, complete. For medium-scale needs, Recomp II can be leased beginning at $2,495. A complete line of peripheral equipment is available for both.

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VHF/UHF Telemetry Receiver

Defense Electronics, Inc. is marketing the TMR-5A VHF/UHF telemetry receiver, a double conversion superheterodyne of modular construction. It consists of a basic unit occupying 10½-in. of rack space with two pull-out drawers. The RF drawer contains all front-end circuitry and both conversion processes, while the video drawer contains the plug-in IF strips and demodulators. Either drawer may be removed by using a "single-motion" locking handle. Nine RF heads cover the range from 55 to 2300 megacycles, and 11 plug-in IF strips are provided with band-widths ranging from 10 kc to 1.5 mc. Plug-in demodulators are also available for FM and PM signals, with an AM demodulator built into each IF strip.

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UHF Oscillator Tube

A seven-pin miniature tube for use in UHF oscillator applications up to 1000 mc is available from the Westinghouse Electronic Tube Div. It can be supplied in three versions: the 2DX4 rated at 2.4v and 600 ma; the 3DX4 rated at 3.2v and 450 ma; and the 6DX4 rated at 6.3v and 200 ma.

The tube has low inductance, twin plate and grid connections, and short stem leads for a high upper-frequency limit. The basing of this tube is the same as the conventional types previously used in UHF oscillator applications and in most cases is directly interchangeable.

With 85 volts d-c plate voltage and 150 ohms cathode bias, the plate current for the tube is 10 ma and the transconductance is 11,000 μmhos. Typical operation in a 1000-mc JEDEC standard oscillator with 100v on the plate results in a plate current of 14 ma and a grid current of 250 ma.

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Write for literature to Environmental Control Systems, AiResearch Manufacturing Division, Los Angeles.

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Electrol, Inc. offers a portable heating device that will provide a man with a continuous supply of fresh air at room temperature while ambient temperatures drop as low as −40°F.

Originally developed for military applications, the 13-lb. unit has a self-contained thermostatic control, which can maintain a constant suit temperature at approximately 75° (or some other preselected temperature) while outside temperatures range from −40° to 15°. Called Polar Pak, it will protect the wearer for a minimum of 1 hr., depending upon the wearer's physical activity, the type of suit with which it is worn, and weather conditions. The fresh air provided by the unit may be used for respiratory purposes or solely for comfort requirements, or both, depending on the design of the suit.

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Soniline Delay Lines

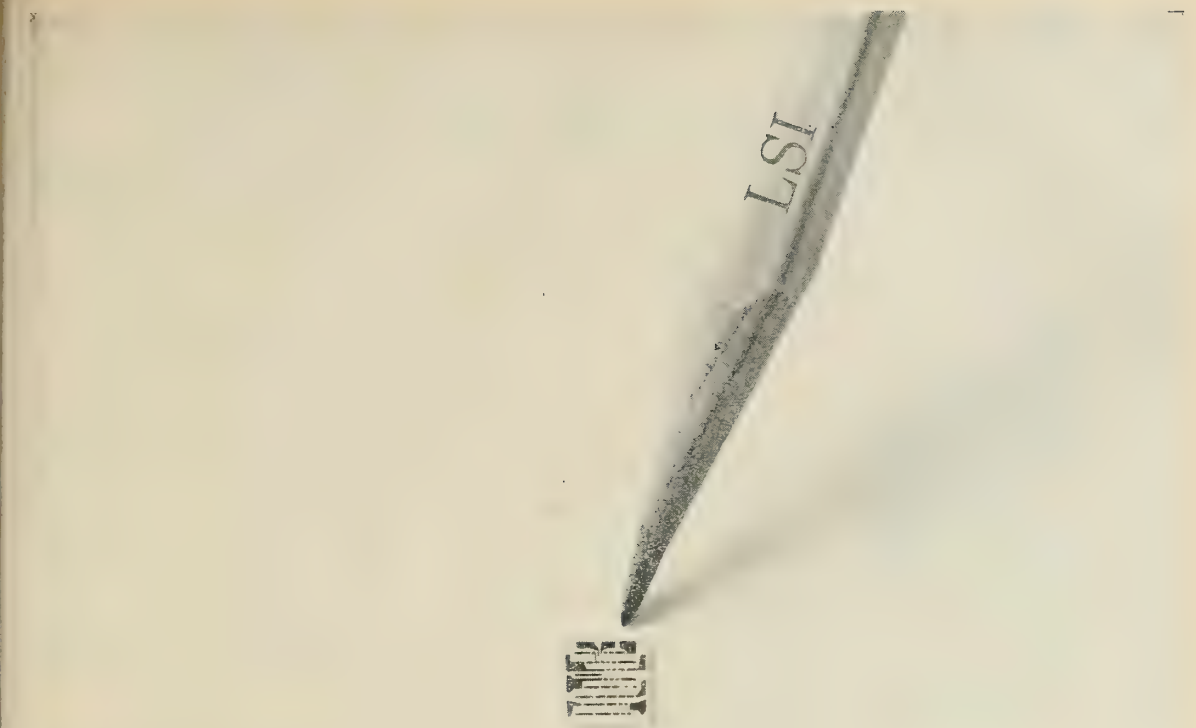
Computer Control Co., Inc. is offering a comprehensive data package on 3C Soniline magnetostrictive delay lines. Capable of delays from 4 to 20,000 microseconds and delay-to-rise time ratios as great as 30,000 to 1, 3C Sonilines provide the system designer a wide range of electrical and physical characteristics. The data package includes specification sheets detailing standard features and available options on each of 12 models together with an introduction to magnetostrictive delay lines.

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Impedance-Admit Meter

Dranetz Engineering Laboratories, Inc. is marketing a complex impedance-admittance meter. The instrument is a portable, completely transistorized, self-contained device for direct reading of equivalent series resistance and reactance or equivalent parallel conductance and susceptance. Readings are presented on precision panel meters and d-c outputs are provided for X-Y or strip-chart recorders. It measures capacitors from less than 10 pfd to 50 mfd and inductors from 10 microhenries to 50 henries full scale, ranges depending on frequency of applied voltage. This instrument is of particular value for materials research, sonar and ultrasonic transducer measurements, amplifier and filter design. Frequency range is 100 cps to 200 kc; impedance range, 12 ranges from 10 ohms to 50,000 ohms full scale (higher using admittance mode); admittance ranges: 10 micromhos to 50,000 micromhos full scale; basic accuracy (vector) 2% amplitude and two degrees phase up to 150 kc.

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Alexander F. Brewer: Named assistant director of electronics at Thompson Ramo Wooldridge, Inc.'s Space Technology Laboratories, Redondo Beach, Calif.

David P. Wilkinson: Elected vice president-corporate planning of Electronic Associates, Inc., Long Branch, N. J.

Norwood P. Cassidy: Appointed director of planning for Belock Instrument Corp., College Point, N. Y.

Peter J. Durnin: Named executive vice president of Rosae, Inc., Eau Gallie, Fla.

George A. Strichman: President and chief executive officer of Fairbanks Whitney Corp., New York City, elected chairman of the board.

J. Harry Frankfort: Named area manager, project development department of Vitro Engineering Co. division of Vitro Corp. of America, New York City.

Arthur R. Fichter: Appointed director of marketing of Kollmorgen Corp., Northhampton, Mass.

Lawrence Golding: Named director of the weapons system safety department at Martin Co.'s Denver Div.

Ralph Ostrich: Appointed an operations analyst at Research Analysis Corp., Bethesda, Md.

Leonard Goldman: Joined Airborne Instruments Laboratory Div. of Cutler-Hammer, Inc., Deer Park, N. Y.

Robert A. Grace: Joined the life support department of Whirlpool Corp.'s Systems Div., Benton Harbor, Mich., as an associate research physiologist.

Dr. R. H. Beaton: Named general manager of General Electric Co.'s Spacecraft Dept., Valley Forge, Pa.

Jack N. Brown: Appointed director of marketing for Space-General Corp., El Monte, Calif.

Dwain B. Bowen: Joined staff of Electro-Optical Systems, Inc.'s Quantum Physics Div., Pasadena, Calif., as manager of laser applications. **Abraham Jacoby** also joined E-O as a senior engineer in the Quantum Physics Div.

Corbin A. McNeill: Elected vice president and director of industrial relations, International Telephone and Telegraph Corp., New York City. **Frank P. Barnes** was elected vice president and director of telecommunications marketing.

Frank R. Herud: Named assistant chief engineer for advanced development at Textron's Bell Aerosystems Co., Buffalo, N. Y. **Arnold R. Kimball** was named manager of rockets marketing.

Charles H. Sinex: Named manager of advanced planning for Pan American's Guided Missile Range Div. **Creed W. Medford** was appointed manager of operations control.

Col. Bernard R. Luczak: Named project manager for the *Nike Hercules* Project Office, Redstone Arsenal, Huntsville, Ala.

Thomas D. Bryant: Appointed a vice president of the Librascope Div. of General Precision, Inc.'s Information Systems Group, Glendale, Calif.

Lawrence E. Hamilton: Joined the Systems Div. of Giannini Controls Corp., Duarte, Calif., as a project manager.

Kenneth S. Yamamoto: Appointed manager of Networks Special Products Div., Networks Electronic Corp., Los Angeles.

Anthony W. Harris: Named assistant for public relations for Allied Research Associates, Inc., Concord, Mass.

Donald R. Squier: Appointed marketing manager-systems for the Aero-Space Div. of Walter Kidde & Co., Inc., Belleville, N. J.



They Wanted High Reliability

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when and where

FEBRUARY

Fourth Electrical/Electronic Trade Show, Denver Hilton Hotel, Denver, Feb. 18-19.

Conference on Crew Escape Techniques for Aerospace Vehicles, sponsored by Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Feb. 19-20.

American Society for Quality Control Annual Reliability Symposium, Statler-Hilton Hotel, Los Angeles, Feb. 20.

1963 International Solid-State Circuits Conference, sponsored by IRE, AIEE, and University of Pennsylvania Philadelphia, Feb. 20-22.

American Society for Quality Control, Quality Control Conference, Flamingo Hotel, Las Vegas, Feb. 21-22.

Society for Nondestructive Testing and Southwest Research Institute Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, Granada Hotel, San Antonio, Tex., Feb. 26-28.

Society of Plastics Engineers, Annual Technical Conference, Biltmore and Statler-Hilton Hotels, Los Angeles, Feb. 26-Mar. 1.

American Physical Society Meeting, Rice University, Houston, Feb. 28-Mar. 2.

MARCH

American Society for Quality Control Annual Seminar, Engineers Club, Dayton, Ohio, Mar. 2.

American Society of Mechanical Engineers, Aviation and Space, Hydraulic and Gas Turbine Conference and Products Show, Statler-Hilton Hotel, Los Angeles, Mar. 3-7.

1963 Microminiaturization Congress, Sheraton Hotel, Philadelphia, Mar. 5-7.

Institute of the Aerospace Sciences National Propulsion Meeting, Pick-Carter Hotel, Cleveland, Mar. 7-8.

American Society for Quality Control, Annual Control Forum, King Edward Sheraton Hotel, Toronto, Can., Mar. 9.

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Conflict of Interest

ONE OF THE UGLIEST terms that can be used in connection with members of this industry is conflict of interest.

The Kennedy Administration has taken a number of steps to assure that overt conflict of interest is absent when a missile/space firm employs a retiring or resigning member of the military services.

Unfortunately, there are many gray areas in this regard that are open to question and that the industry prefers to sweep quietly under the rug.

This, we feel, is a mistake. If the industry refuses to clean its own house, someone will clean it for us —to the great detriment of the firms and personnel involved. We would, therefore, like to take a frank look at some of the questionable areas.

It is not sufficient protection against conflict of interest charges to insist that retired military personnel be assigned to programs that are unconnected with their previous Air Force, Army or Navy service. Placing an admiral in charge of Air Force sales does not automatically remove the stigma. The basic problem of conflict of interest goes much deeper than this.

It really starts in the years *before* the individual leaves the service, not *after*. A brilliant flag or field-grade officer sees his former comrades in arms picking off high-salaried posts in industry as they leave the service. Always before him is the implied promise that if he makes decisions favorable to Company X, there will be a comfortable post for him at Company X when he retires

There is the implied threat that if he consistently makes decisions unfavorable to Company Y, there isn't much hope in looking for a future berth in that direction.

We don't suggest for a minute that this is an active factor in the majority of procurement decisions. But it is a fact that many people, including some in high positions, believe it is true.

It is a problem that the industry should face frankly. The appearance of evil can be as damaging as evil itself. To discourage discussion of this and other similar problems is a disservice. The industry itself should take the lead in an attempt to solve them.

There are former admirals and generals with strong management and technical capabilities who are making real contributions to the firms with which they are associated. There are others who were hired because they "know everybody in the Pentagon" or because they claim an influence over junior associates still in the services.

The existence of the second group is denigrating and overshadowing the real value of the first. When a company hires an incompetent colonel who not only couldn't make general but couldn't even successfully manage a shoeshine stand, it is damaging the entire industry on the off-chance a few of his former friendships might be valuable.

Don't tell us this doesn't happen. We've met a number of these incompetents. But just how large a problem is it? A House investigating committee reported some time ago that more than 1400 retired officers from the rank of major up were employed by the top 100 defense corporations.

We question that so many former military men are of real value to the industry.

There also is the question of the "consultant." Many high officers after leaving the services have set themselves up as consultants to a number of missile/space firms. Presumably, they offer sound advice on weapons system planning and requirements. All too frequently, what they offer is Pentagon contacts of value to the military sales department.

Center of much of this activity is the venerable Army-Navy Club in Washington. It might more appropriately be dubbed the Army-Navy-Industry Club. Almost every lunchtime, you can find there the ex-military men now with industry huddling with their colleagues still in the service.

Innocent? Perhaps. Damaging to the image of the industry? Definitely.

WHAT IS THE ANSWER? It lies in part with the military officers concerned. They must question the motives of firms offering them employment, and seek truly worthwhile positions rather than those designed merely to capitalize on their influence.

For example, we find the actions of a former missile general in lending his name to a real estate promotion near Cape Canaveral particularly unappetizing.

But the real solution must come from the industry itself. Industry firms should take a close look at their policies in regard to employment of former military personnel.

We do not believe a truly capable military officer should be denied the opportunity to find a niche in industry where his talents can be used to benefit the nation. But a position in military sales, particularly in Washington, automatically is suspect. We strongly urge industry firms to ponder that fact.

We would like to see the industry take a strong, above-the-board whack at the entire problem. It would clear the air.

William J. Coughlin

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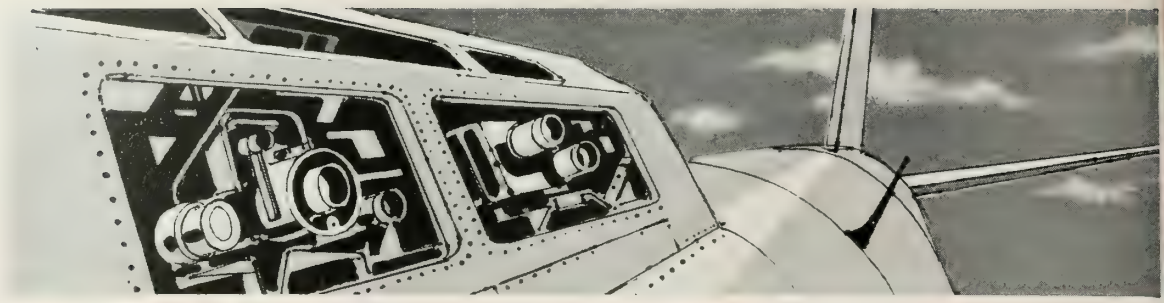
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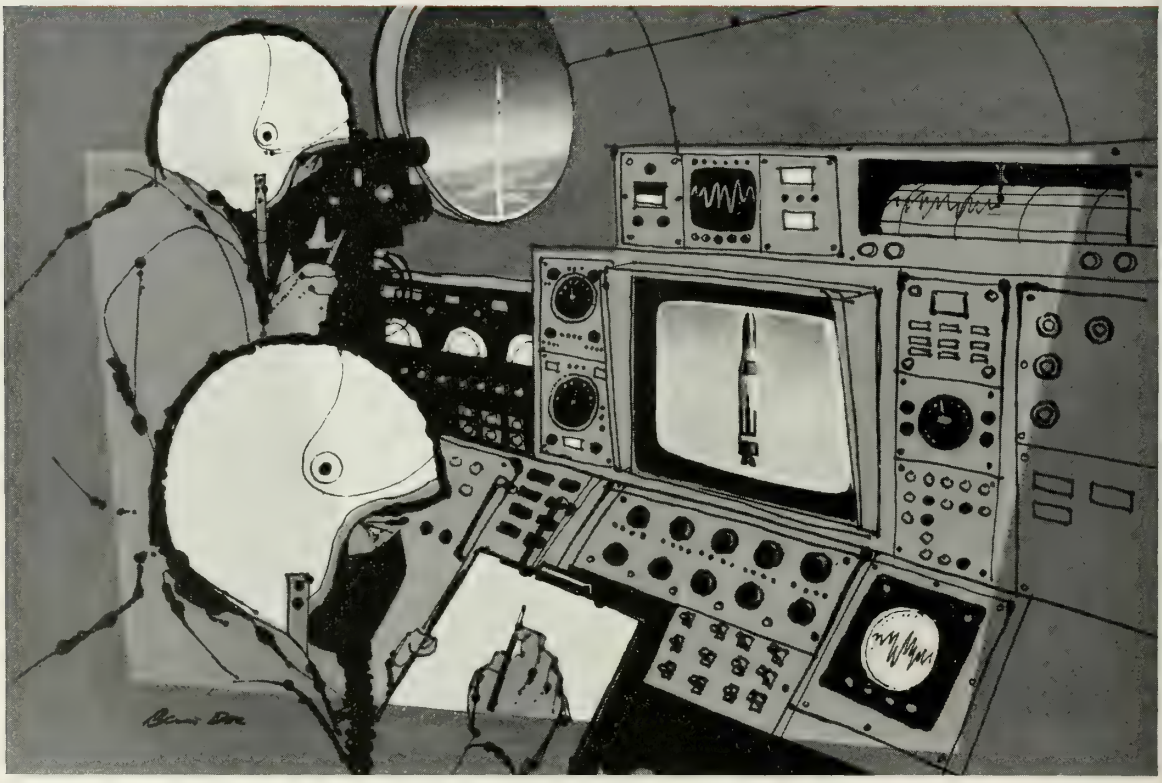
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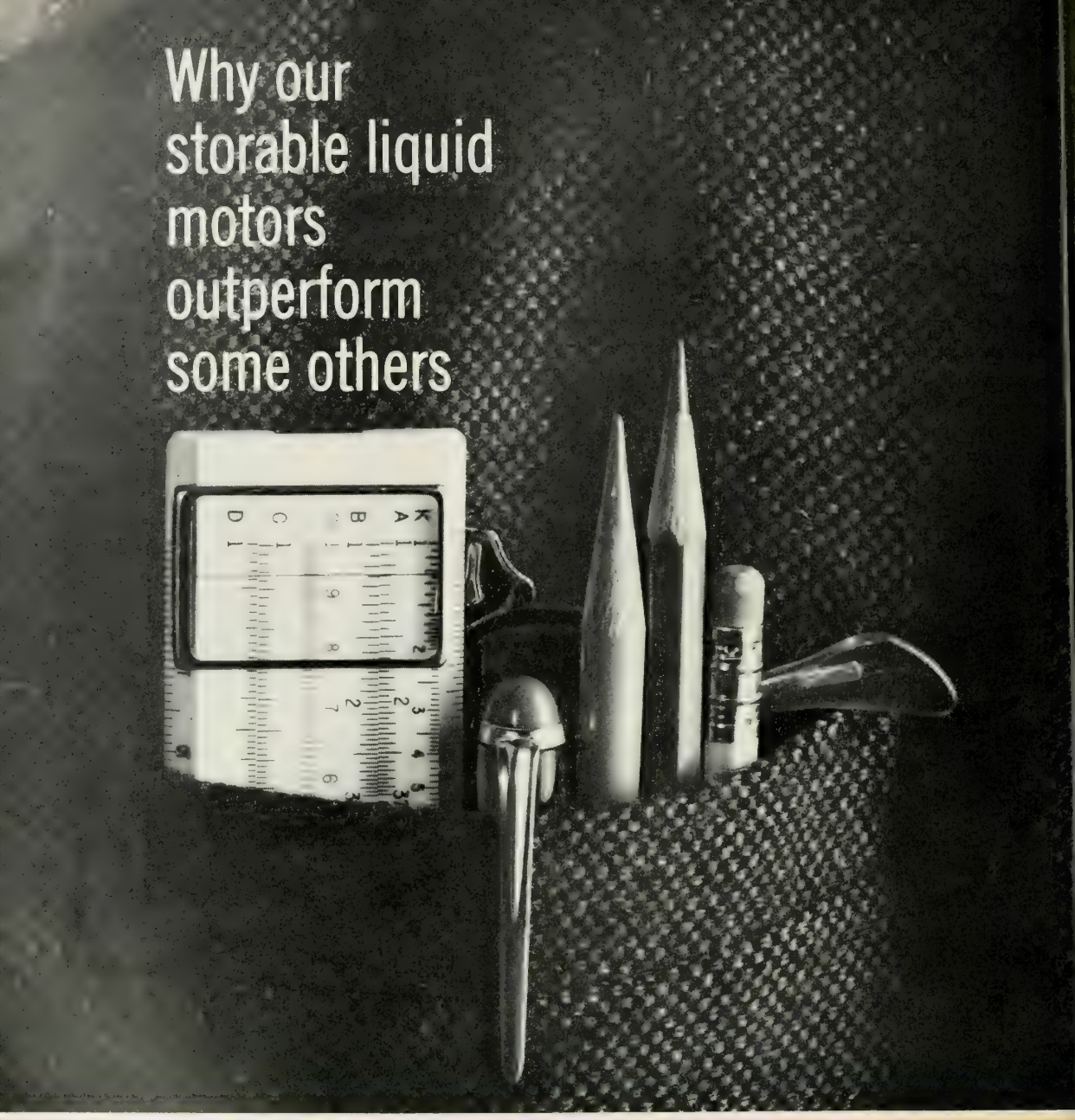
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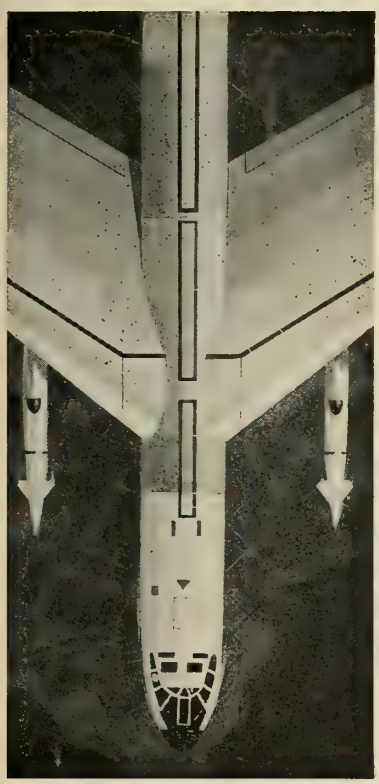
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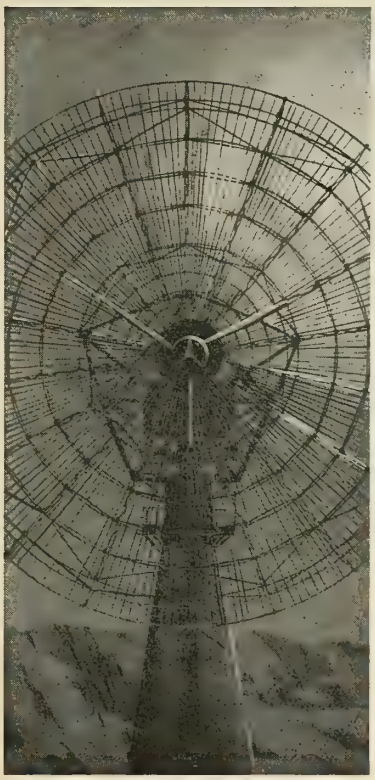
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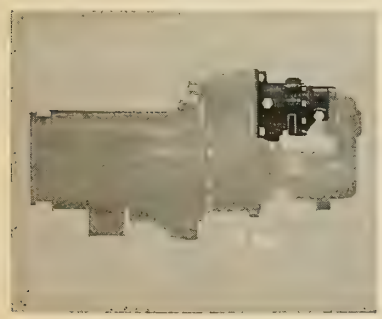
A Kellogg pump, a product of the Aerospace Division of American Brake Shoe, is an important part of the Garrett-AiResearch constant-speed drive—an efficient power source for aircraft cabin air compressors.



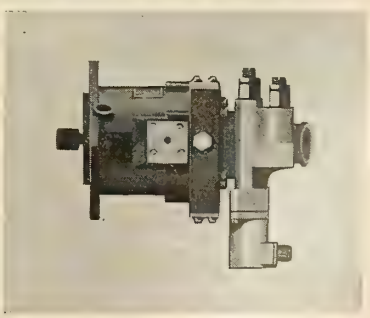
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 8 February 25, 1963

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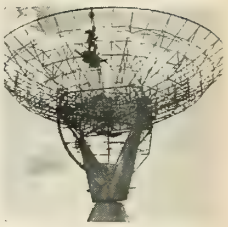
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THE COVER



Big 85-ft.-dia. parabolic reflector is assembled at Radiation Inc.'s Palm Bay, Fla., facility. Antenna is part of high-gain, wideband telemetry system, three of which will be delivered under $1.5-million AF contract for use at AMR, PMR.

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letters

Boeing and Minuteman

To the Editor:

The proud men of Boeing were bewildered and disappointed to read your editorial, "The Proud Men" (M/R, Feb. 11, p. 50), and to find there kudos to the USAF, SATAF, BSD, Army Corps of Engineers, CEBMCO and Fuller-Webb, and never a mention of the company—Boeing—which is responsible for design, assembly, and test of the ground communication and launch control system, the transportation system, maintenance equipment, assembly and test of the complete system, and assembly, checkout and delivery of operational *Minuteman* wings to SAC at the various bases.

In addition to the people at our *Minuteman* operation here in Seattle, we have some 7000 to 8000 people in the field. Their work includes the test program at Cape Canaveral, test and instruction programs at Vandenberg AFB, operation of the assembly plant at Ogden, Utah—and, of course, we have very substantial crews at all the missile sites.

I am sure that omission of Boeing was an oversight, but our people who fought the Montana blizzards and all others on the program who helped achieve "on-schedule" delivery of the first two wings, are rightly proud of *Minuteman* and their part in the program.

Carl M. Cleveland
Director of Public Relations
The Boeing Company
Seattle

Our references to the military/industry team were meant to cover not only Boeing, but Convair and Martin. No slight intended to justly proud men.—Ed.

Astronauts and Ethics

To the Editor:

Over the past several years I have enjoyed the broad picture of our industry which I could get in a brief glance through your magazine.

I feel that your attack on the astronauts ("Ethics of Fame" editorial, Nov. 5) was totally unwarranted and disgraceful. I am, therefore, not renewing my subscription.

K. R. Dunipace
Cocoa Beach, Fla.

Political Blunder?

To the Editor:

I find your editorials excellent. One thing that still bothers me, however, is the government's decision to push the big liquid-propelled booster rockets for the space effort in the near future. Why they didn't allow Thiokol to build the huge solid boosters by giving them a contract still puzzles me. Perhaps your staff could shed some light on the reasons behind this important government decision. I realize that the government has appropriated funds for *some* important work to be done in the nuclear and solid propulsion system areas—but why they continue to appropriate such a high percentage to the highly expensive, complex and perhaps outdated liquid-fueled systems upsets me very much. The U.S. it seems is slow at learning by mistakes. *Polaris* and *Minuteman* have proved themselves far superior to *Atlas, Titan, Jupiter, Thor,* etc. Why the U.S. continues to rely on these outdated systems, while the USSR (without a doubt) is forging ahead, still remains in my mind a political and lobbyist blunder!

Carl H. Gabbert
Madison, Wis.

Testing Institute

To the Editor:

The Sacramento State College Foundation and the Sacramento Chapter of the Society for Nondestructive Testing are sponsoring a two-week Summer Institute on the Principles of Nondestructive Testing, June 17-28, 1963, at Sacramento State College, Sacramento, Calif. The program is designed to train personnel in the fundamentals, principles and proper application of nondestructive test methods. The participation fee is $245. Application forms and additional information can be obtained by writing to:

Summer Institute in Nondestructive Testing
Division of Engineering
Sacramento State College
6000 Jay Street
Sacramento 19, Calif.

George N. Beaumariage, Jr.
Director of Research and Development
Sacramento State College
Sacramento, Calif.

Rules of Contracting

To the Editor:

Your item, "White House Contract Pressure Is Increasing" (COUNTDOWN, M/R, Feb. 11, p. 9), is a public declaration of complete disregard for established contracting regulations. Long-established rules prohibit favoritism in the selection of a contractor. Ability and contract cost are two of the primary deciding factors. White House people should be able to find more important national issues to occupy their attention than selecting a specific contractor to receive political favors. They should read the Armed Services Procurement Regulations and follow them or have them revised.

C. N. Savage
Melbourne, Fla.

Conflict of Interest

To the Editor:

To your Feb. 18 editorial ("Conflict of Interest"), I say AMEN.

Miles Kracman (Lt. Col. USAF Ret.)
(Happy with Bendix Missile Div. for the last 5 years)
Mishawaka, Ind.

Circle No. 20 on Subscriber Service Card



A practical solution to the problem of communications with the X-20 pilot—during launch and on his orbital path over the Atlantic Missile Range—has already been outlined by the engineers and scientists of PAN AM's Guided Missiles Range Division at Cape Canaveral.

Already a special staff of Engineering Program Managers at GMRD is preparing master plans for range development—encompassing facilities and instrumentation systems for tracking, telemetry and communications support of the X-20 space glider program. Working closely with the Air Force and X-20 contractors, they are tailoring range specifications to match the demanding requirements of orbital rendezvous and docking techniques by a manned space glider.

As contractors for the development, engineering and operation of the Atlantic Missile Range for the Air Force, GMRD presents recommendations for new equipments, then writes the specifications for authorized new instrumentation and facilities, and monitors their development by industry, their installation and acceptance testing.

Staff expansion is under way at GMRD to meet the range technology needs of the next 15 years. You are invited to inquire about career opportunities for:

Systems Engineers—EE's, Physicists capable of assuming complete project responsibility for new range systems.

Instrumentation Planning Engineers—EE's, Physicists to be responsible for specific global range instrumentation concepts.

Advance Planning Engineers—EE's, Physicists to evaluate and project the state-of-the-art in all applications of range instrumentation.

Experience in one or more of these areas: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, underwater sound, timing, shipboard instrumentation.

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Dept. _____. Pan American World Airways, Inc., P.O. Box 4465, Patrick Air Force Base, Florida.

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GUIDED MISSILES RANGE DIVISION

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This photo-optical space chamber—largest of its kind—simulates altitudes of 380 miles ($4x10^{-9}$ mm Hg). In this 3,000 cu. ft. chamber, near-infrared, TV and photographic sensory systems are performance tested in aerospace environments. Other types of equipment, even complete satellites and spacecraft, are also checked out here. Capabilities of the chamber include temperatures from −100°F to + 300°F, and vibration of 28,000 force-pounds to 300,000 feet. A high resolution photo-optical test system beneath the chamber features a collimator array with a vertical focal length of 27 feet. Terrain motion is simulated with dynamic resolution targets.

For more details on this unique testing facility write for brochure: "Facilities and Capabilities—an Eye to the Future." Address Fairchild, Department 3, Robbins Lane, Syosset, N. Y.

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The Countdown

WASHINGTON

MIDAS Detects Solid and Storable-Fueled Missiles

Anticipated trouble of *MIDAS* sensors in detecting launches of *Polaris* and *Titan II* ICBM's has failed to materialize, COUNTDOWN is told. The satellite has had little difficulty in detecting these signatures as well as those of RP-1/LOX pad-launched missiles. Main difficulty remains one of background.

Development Troubles in SUBROC

Industry sources say early development troubles account for Navy reluctance to talk about the *SUBROC* test program under way in the Pacific. Reason: Navy fear of financial scrutiny of the program.

Martin Tests Bullpup Training Missile

Martin-Orlando is testing a full-sized *Bullpup* training missile for the Air Force. Development of the missile under an AF contract was initiated after tests with the *TGAM-83* showed it lacked sufficient thrust to successfully simulate *Bullpup* missions. *TGAM-83* has been cancelled.

NASA Changes Approach to Nova Vehicle

NASA is taking a new tack with its *Nova* launch vehicle studies. Officials say future studies will be aimed at orienting the big booster to the requirements of its manned interplanetary spaceflight mission—rather than simply pegging its size at two to three times the *Saturn V*. With NASA now talking about a 1981 target for the first manned planetary landing, *Nova* development funding will be delayed until at least Fiscal '66.

Project Orion Still under Consideration

Project *Orion*, calling for development of a space rocket powered by nuclear bombs (M/R, Oct. 29, p. 28), still is making the rounds. High defense officials tell COUNTDOWN that no decision has yet been made on the program. Its absence from the last Pentagon budget is a good clue—but it's not dead yet.

NASA Asks Proposals on Apollo Materials

NASA's Manned Spacecraft Center has asked for industry proposals on a program to conduct more than 264 studies of materials to be used in the *Apollo* heat shield. Proposals are due March 4. Plans call for plunging samples of heat shield materials into plasma jet torches.

Navy Gets Ready to Defend the Fleet

Navy has been asked to prepare a case in defense of its surface fleet as a worthwhile investment. Prelude: Secretary McNamara's Congressional testimony in which he questioned the fleet's usefulness in the light of the huge outlays "merely to defend the fleet against air attack." Opening shot in the Navy's rebuttal was the Feb. 8 speech by Adm. George W. Anderson, Chief of Naval Operations, in which he spelled out point-by-point the accomplishments of the fleet and repeatedly emphasized that it is essential—something which no one other than Mr. McNamara has questioned recently in public.

B-52 Troubles May Be Key to Skybolt

Nothing has been said publicly yet but it may be necessary to begin grounding the aging B-52 aircraft fleet for a $500-million modification program. Reason: fatigue. This could have been another major factor in the decision to cancel the *Skybolt* ALBM.

NASA Admits Titan III Meeting

After officially denying that such a meeting took place (M/R, Feb. 11, p. 9), NASA spokesmen now admit that a NASA-Air Force meeting was held at Marshall Space Flight Center this month to discuss *Titan III*. NASA says, however, that the meeting was at AF instigation and that no NASA mission for the booster was discussed. In return, NASA plans to brief AF on the *Saturn V*.

Davy Crockett: Lost in the Woods?

Although denying that a cutback is planned in the *Davy Crockett* nuclear missile program, Dept. of Defense officials concede that the tactical weapon's deployment still is under study. Numbers, location and circumstances of deployment still are in question. Significantly, an Army speech listing equipment for the new mechanized divisions omits *Davy Crockett*—which received prominent mention in the previous listing only six weeks ago.

INDUSTRY

North American Receives Apollo Payment

North American Aviation recently received a $100-million payment from NASA under its prime contract for the *Apollo* spacecraft. This brought total funds committed to the project to $260 million since signing of the contract on Dec. 21, 1961.

Single Nozzles Planned for Missiles

Fashion trend for missiles is to single nozzles. An *Advanced Polaris* with a single-nozzle first stage may be tested this year. Plans are to flight-test at least two of the new nozzle units on *A-2* motors. *Advanced Minuteman* may join the trend with a new second stage and a nozzle with a 48-in. exit diameter. Present *MMRBM* studies also indicate a single-nozzle first stage for that missile.

NASA Details Plans for Electronics Center

NASA plans to have 250 permanent employees working at its proposed Electronics Research Center by the end of Fiscal 1964. The center, which will be located in the greater Boston area if Congress approves funding, will be broken down organizationally into four major offices: technical services, administrative division, electronics division, and guidance and control division.

INTERNATIONAL

British Display Blue Steel Missile

Britain's *Blue Steel* missile was demonstrated to the press last week in a mock mission officially dubbed "Destination Leningrad." Two Vulcans carried the air-to-surface missiles aloft on a five-hour flight—long enough to strike at Leningrad and return on a 2400-mi. roundtrip. British sources report that of the last 10 *Blue Steel* firings at Woomera, 9 were complete successes.

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NASA's OMSF Realigned

NASA's Manned Space Flight Office Director D. Brainerd Holmes named two Deputy Directors—Dr. Joseph F. Shea and George M. Low—in a Feb. 20 realignment of the office's management.

Under the new organization, Shea, who formerly headed the OMSF Systems Directorate, becomes Deputy Director for Systems. Reporting to Shea will be Dr. William A. Lee, Director of Systems Studies; John A. Gautraud, Director of Systems Engineering; and James E. Sloan, Director of Integration and Checkout.

Reporting to Low as Deputy Director for OMSF Programs will be the Director of Launch Vehicles, Milton Rosen; the Director of Space Medicine, Dr. Charles Roadman; and the Director of Spacecraft and Flight Missions, a post to be filled but currently held by Low.

William E. Lilly, Director of Administration, will provide administrative support in both major areas.

In a related action, the Manned Space Flight Center announced reorganization of the *Apollo* Spacecraft Project Office.

Charles F. Frick, *Apollo* project manager, said Robert O. Piland will be Deputy Project Manager for LEM, the module that will carry two astronauts to the Moon's surface.

James L. Decker will be Deputy Project Manager for the Command and Service Modules.

Frick said the two deputy managers will be responsible for the costs, schedule, technical design and production of the three-module *Apollo* craft.

Little Joe Contract Finalized

NASA has announced a $6.3-million finalized contract for the manufacture of *Little Joe II* suborbital launch vehicles, launchers and range support.

The contract, with General Dynamics/Corvair, calls for four *Little Joe II* vehicles, two launchers, and support at White Sands Missile Range, N.M.

The *Little Joe II*—designed as an economical and expendable launch vehicle for testing boilerplate models of the *Apollo* spacecraft in unmanned, suborbital flights—is scheduled for first flight in mid-1963.

Now being fabricated and assembled at the General Dynamics/Corvair plant in San Diego, Calif., the first *Little Joe II* will be able to accommodate as many as seven solid-fuel Algol engines developing a maximum thrust of about 800,000 lbs. The vehicle has been designed for an *Apollo* payload of 80,000 lbs.

Anderson Views Future Funds

"Knowledgeable men say that the space budget can be counted on to rise a few more billions, then level off through the end of the decade. I have seen informed projections, however, looking toward a possible space expenditure by 1970 in the vicinity of $10 billion.

"That level does not seem beyond reason . . ."

These are the views of the new chairman of the Senate Aeronautical and Space Sciences Committee, Clinton P. Anderson (D-N.M.), as he expressed them in a recent report to his constituents.

The senator estimated FY '64 space expenditures at $6.1 billion. He went on to say that he expects considerable growth in future space budgets.

Radiation Altimeter Sought

NASA's Manned Spacecraft Center is requesting proposals by March 13 for a low-level radiation altimeter which it says offers one of the most promising ways of solving the guidance problems for lunar touchdown.

As many as four packages of radioactive materials would be jettisoned from the *Apollo* Lunar Excursion Module when it is 100 ft. from the Moon's surface. They would land 25 ft. from the local vertical. Short-lived radioisotopes were suggested to avoid contamination of the Moon.

Directional radiation detectors on the LEM would scan the radiation packages and permit astronauts to guide their spacecraft down between the radioactive beacons. Constant emission from gamma rays should permit altitude determination of plus or minus one foot.

Two types of systems were proposed by the center. One would be a direct radiation flux system, with the gamma radiation emanating from the sources directly to the LEM. The other would use "backscatter" radiation measurement, with the radiation bouncing off the surface of the Moon first.

ComSat Financing Disputed

A dispute has developed over who is to finance future development of communications satellite technology —the government or the private corporation authorized by Congress last year.

"Why shouldn't all the research be done by the corporation?" asked Acting Chairman John O. Pastore (D-R.I.), at a recent hearing before the Senate Commerce Committee. He was referring to the work that must be done to develop devices more sophisticated than the current crop of *Telstar, Relay* and *Syncom* experimental satellites.

Pastore urged the space committees of both houses of Congress to give NASA requests for ComSat research funds "a very hard look" when these items come up in budget hearings this session.

Dr. Hugh Dryden, deputy NASA administrator, told the committee that "because we are dealing with a strange and new technology," it will be necessary for the government to support much of the research effort.

Dryden's reply that NASA expects to limit its research to "the very difficult problems" of high-altitude synchronous systems, leaving work on low-altitude systems to the corporation, did not appear to satisfy Pastore.

Shots of the Week

Failures or only partial success characterized launch efforts at U.S. missile ranges last week.

- The most spectacular attempt was the Feb. 14 launch from Cape Canaveral of NASA's *Syncom* active communications satellite. The 150-lb. satellite initially seemed to have achieved its difficult "hanging" orbit 22,300 miles up, but trackers lost contact with the craft just as its "apogee kick" rocket fired to boost it into the proper orbit.

Syncom was still lost late last week and Dr. Hugh Dryden, deputy director of NASA, said there was speculation the apogee-kick rocket exploded at the height of the payload's trajectory. If this happened, he said, it would have driven the rocket into the instrumented payload, or would have smashed the payload to pieces.

- The first attempt to fire a *Titan II* from a silo failed partially Feb. 16

at Vandenberg AFB. The Martin missile blew up because of an umbilical rigging problem in the silo, which imparted a spin of about one revolution per minute to the ICBM as it came out of the hole.

Extreme and rapid control responses to this twist apparently overstressed the *Titan II*, according to Martin engineers, and it exploded about 20 sec. after launch.

• Failure also dogged the Feb. 18 try for a third straight successful *Polaris A-3* flight. The Lockheed missile's first stage performed perfectly after launch from a Cape Canaveral land pad. But a range safety officer destroyed the *Polaris* when the second stage began to wobble after ignition. The wobble had caused the missile to careen wildly from its course.

• An Army *Pershing* launch Feb. 14 from Cape Canaveral was termed a partial success. The warhead did not separate from the second stage and fell far short of the target area 200 mi. down the Atlantic Missile Range. The Martin missile had recorded eight straight successes.

• A NASA sodium vapor rocket fell into the Atlantic Ocean Feb. 18 after being launched from Wallops Island, Va. The *Nike-Asp* rocket was to have measured wind speed and direction at an altitude of 100 mi. NASA blamed the failure on second-stage problems, which prevented the rocket from attaining altitude and releasing its pink and yellow sodium vapor trails.

• An Air Force *Blue Scout* rocket booster carried another secret satellite aloft from Pt. Arguello, Calif., Feb. 19. No further details on the launch were revealed.

• A more cheerful note, however, was added by the night launch of a *Minuteman* from the Cape Feb. 20. The Air Force said the 3000-mi. R&D flight was a complete success.

Big Typhon Contract Awarded

Navy has awarded a $25-million contract to the Mishawaka (Ind.) Div. of The Bendix Corp. for research and development on the medium-range *Typhon* missile system.

First increment of funds to be available is $3.4 million. Work on the medium-range *Typhon* is to be coordinated with work now being performed by Bendix-Mishawaka on the *Talos* and long-range *Typhon* missiles.

Explorer XVI Being Punctured

Explorer XVI, launched last Dec. 16 to gather information on micrometeoroids, was punctured 16 times during its first 29 days of flight, NASA's Langley Research Center reports.

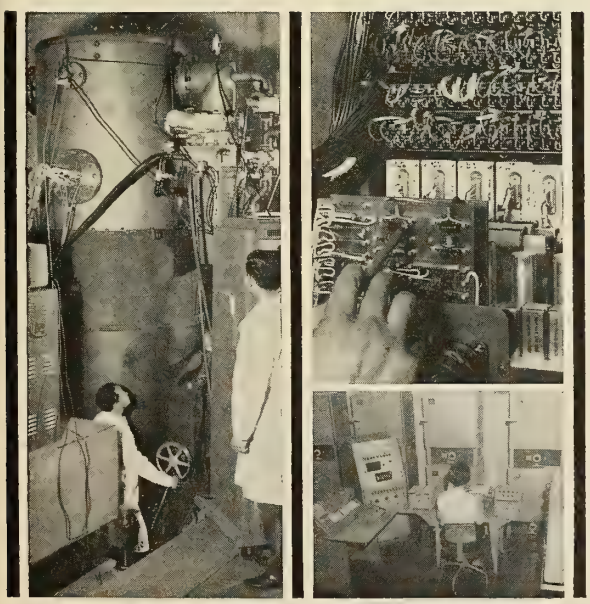
Other hits, not strong enough to penetrate, were recorded on sensitive sounding-board devices, but the information on counting rates is still being analyzed.

The satellite project—directed by the NASA Office of Advanced Research and Technology (OART) is designed to find out whether micrometeoroids are hazardous to space vehicles.

Ten punctures were recorded in a group of 0.001-in.-thick beryllium-copper pressurized cells. One occurred in a similar cell 0.002-in. thick, but 0.005-in. cells reported no punctures.

Two foil gage detectors furnished by the Lewis Research Center were punctured during the 29-day reporting period. Each was protected by a 0.001-in.-thick skin of stainless steel. Similar detectors covered by 0.003- and 0.006-in. steel skins did not report any punctures.

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AERIAL VIEW shows work under way at Cape Canaveral to convert former Titan I launch pad to Titan III complex.

New cost analysis . . .

Titan III Program Reappraised

Backers fear downgrading of Dyna-Soar; DOD orders fresh price study; new test plans announced, nozzle contract awarded

AIR FORCE and industry sources were concerned this week about a new Defense Dept. evaluation of the *Titan III* space booster program.

Concern centered around reports that a DOD reappraisal of the *X-20 (Dyna-Soar),* for which *Titan III* is the launch vehicle, might result in its being downgraded to a mere test program for *Aerospace Plane,* the proposed AF-NASA manned hypersonic spacecraft.

At the same time, AF officials were hard at work on a new cost analysis of the *Titan III* program undertaken on orders of Secretary of Defense Robert S. McNamara. Results of the study may be made public next week.

The "additional review" apparently was instigated by a recent memorandum from McNamara's office to Air Force Secretary Eugene Zuckert. The memorandum was written following McNamara's testimony on Capitol Hill last month, during which he declared that "because *(Titan III)* is justified primarily as a cost-saving program, its continued development will depend upon achievement of the cost objectives."

Presumably, the new AF cost report will be ready when Lt. Gen. James Ferguson, deputy chief of staff for research and technology, testifies on *Titan III* before the House Science and Astronautics Committee. He is scheduled to appear next week.

Despite the ordering of a fresh cost study, an AF spokesman said he thought *Titan III* "is not in trouble." He noted that it was not unusual for a program of such scope to undergo re-analysis.

At Cape Canaveral, AF officers said they plan to use 17 *Titan III's* in the test and development program due to begin there in late 1964.

Launching *Dyna-Soar* is the only specific military mission yet to be indicated for *Titan III,* but AF R&D officials stress that there are other reasons for developing the big booster, which they see as a workhorse for both military and NASA launches of numerous kinds.

Titan III qualifies, they believe, for other launching jobs in the relatively near future—among them the synchronous-orbit version of the re-oriented *Advent* communications satellite, and *MODS (Military Orbital Development Station),* the Air Force concept of two or more *Gemini*-type vehicles joined in orbit.

Although the alternative *Saturn I* booster has already flown—and first *Titan III* launches aren't scheduled until FY '64—AF officials contend the *Titan* would offer much cheaper, faster, more versatile launch capability. They say *Saturn I* would require more post-launch repairs to the pad, and hence tie up the launch area for 30 to 60 days, compared with the 15 days or less which is the goal for *Titan III.*

As for *Dyna-Soar,* some DOD research and development officials were citing the NASA-DOD accord for cooperation in the *Gemini* program, and

implying that a similar arrangement might later be made for *Apollo*. At the same time, many designers in industry and DOD have indicated privately that they believe the *Dyna-Soar* program has been over-managed and delayed so much that its technological contributions to manned spaceflight will not justify its cost.

• **Seventeen planned**—At the Cape, meantime, the AF revealed that a minimum of 17 *Titan III's* have been scheduled for the 45-month test-and-development program which is slated to begin in the fall of 1964.

The figure was revealed during brief ceremonies held at the Cape last week to mark the starting of dredging operations needed for construction of the missile assembly, checkout and launch facilities.

Col. Joseph S. Bleymaier, program director, said the test program will include five *Titan III-A* vehicles and 12 *Titan III-C* combinations. He added that this figure will stand "if we meet all objectives and have no engineering problems."

The *Titan III-A* will be a modified *Titan II*. The modification will consist of addition of a liquid-fueled third transtage that will incorporate a control module to house guidance and flight-control systems for the entire vehicle.

The transtage also will provide 16,000 lbs. of thrust and will have a multiple restart capability. It will utilize the same fuels used in the *Titan II* upper and lower stages.

The *Titan III-C* will consist of the *Titan III-A* with two 120-in., five-segment, solid-propellant rockets that will develop more than two million lbs. of thrust and serve as the first-stage booster for the *III-C* combination.

Bleymaier said present plans call for the five *Titan III-A* boosters to be launched first. He said the first two will fly low Earth orbits with direct injection. The other three will involve more sophisticated trajectories and use the transtage.

The overall *Titan III* program would provide five distinct types of missions. Bleymaier said these are: low Earth orbit with direct injection; low Earth orbit with precise injection; low Earth orbit with transfer to a different altitude or plane; placing payloads in synchronous orbit; and escape missions.

The construction program, which includes the Vertical Integration Building, Solid Motor Assembly Building and Pads 40 and 41, will go out in four bid packages. Construction of the overall Integrated Transfer Launch Facility will be supervised by the Army Corps of Engineers.

The solid motor segments will be brought to Cape Canaveral by a railroad which will be constructed soon to connect NASA's Merritt Island operation with the mainland. It will be the first railroad line to serve the Cape area.

The first-stage units of the *Titan III-C* will be strapped to the central section in the solid motor assembly building and the complete booster will be transported to the pad on rail units powered by twin diesel engines.

Bleymaier said most of the contracts are continuations of pacts in effect for the *Titan II* for airframes, engines and guidance. Martin will construct the airframes, Aerojet-General will make the engines and AC Spark Plug will furnish the guidance. United Technology Center will produce the 120-in. first-stage engines.

All these contracts, Bleymaier added, call for an incentive payment based on lower costs, meeting schedules and success of the vehicles.

The Ralph M. Parsons Company will furnish architectural engineering and design of the Integrated Transfer Launch system, and Aerospace Corporation will be responsible for systems engineering and technical direction of the program.

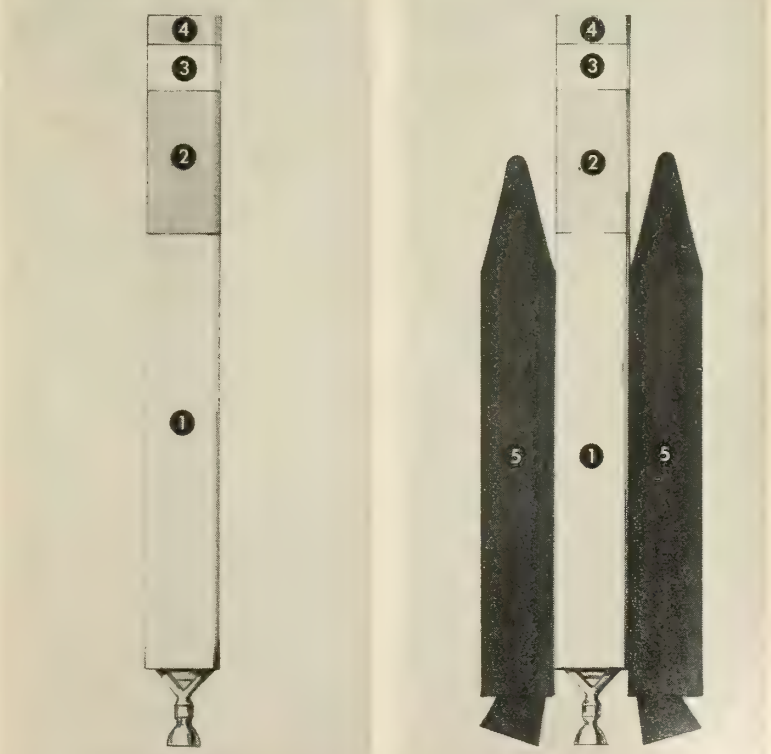
• **Nozzle award** — A new contract for nozzles for the *Titan III-C's* first-stage solid booster motors went last week to H. I. Thompson Fiber Glass Co., of Los Angeles.

The first full-scale reinforced plastic nozzles are to be delivered to United Technology Center, prime contractor for the strap-on boosters, by mid-year.

They will be used for development, preliminary flight rating, qualification and flight-testing of the 120-in. motors. Nozzle diameter is also reported as 120 in. Amount of the contract was described only as "multimillion-dollar."

Nozzles will be fabricated in HITCo's Hydroclave/Autoclave, which has an inside diameter of 132 in. and depth of 170 in. They will be wrapped and machined on a lathe with an 85-ft. bed and 160-in. swing.

The HITCo contract is the first of two which will be awarded for parallel nozzle development. A second is expected to be announced shortly. Full production contract will be awarded after evaluation of the two approaches has been completed. ⌘



AIR FORCE DRAWINGS show two planned standard configurations of Titan III launch vehicle. Titan III A (left) consists of (1) a Titan II first stage; (2) Titan II second stage; (3) transtage; and (4) control module. Titan III A would have lift-off thrust of 430,000 lbs. Titan III C (right) consists of "A" configuration with the addition of two five-segment strap-on UTC motors (5). Each 120-in. strap-on booster will develop more than 1,000,000 lbs. of thrust.

Longer Moon stay planned . . .

LEM Subs To Be Chosen by Summer

Rocketdyne and soon-to-be-selected company will make parallel studies of descent propulsion

by Hal Taylor

NASA and the Grumman Aircraft Engineering Corp. expect to complete selection of major Lunar Excursion Module subcontractors in about four months.

The next major step will come in about two weeks, when proposals will be requested for parallel development of a descent propulsion system for LEM—destined to land the first U.S. astronauts on the Moon.

Grumman is already negotiating with Rocketdyne Division of North American Aviation, Inc., for development of a descent stage with a helium injection engine.

But Frank Canning, assistant project manager for Grumman, LEM prime contractor, calls the descent propulsion system "the biggest development problem in the program."

As a result, he said, a decision has been made to initiate a parallel development program. The new request for proposals will call for a non-gaseous throttling device which could use variable injection or some other solution to the problem of varying stage thrust. The LEM descent stage reportedly will have a thrust of over 10,000 lbs., with a requirement for a throttling ratio of 10 to 1.

• **Radar needs scrutinized**—Canning said about two more months of study will be needed before it is possible to select a firm to develop a LEM radar system. The studies will be conducted by both Grumman and the Massachusetts Institute of Technology's Instrumentation Laboratory, prime contractor for guidance and navigation.

He also reported that Grumman plans to use as much as possible equipment that is common with the *Apollo* spacecraft's Command and Service Modules.

Reportedly, this will apply primarily to components rather than major subsystems, such as stabilization and control, electrical power and instrumentation, for which contractors still have not been selected.

This stems, NASA officials report, from the fact that each major LEM subsystem required a unique design, quite different from that of the Command and Service Modules.



RENDEZVOUS and docking techniques for both LEM and the Gemini program will be studied in this simulator at NASA's Langley Research Center. Facility, for which Gered Industries, Birmingham, Mich., was prime contractor, enables two pilots in full-scale Gemini spacecraft to practice contact with target vehicle.

Other details of the LEM program disclosed by Canning included:

—The spacecraft is now designed as a 22,000-lb. vehicle. Its propulsion system, however, will have a payload capability of 25,000 to 28,000 lbs., thus providing wide margin for later growth in capsule weight.

—The ascent stage—which will launch off the lunar surface—will be made of aluminum. Its propulsion system will have a thrust of over 3000 lbs.

—Its reaction control system will be marked by complete redundancy. There will be 16 control jets, each having a thrust of 75 lbs.

—The hydrogen-oxygen fuel-cell system will have 100 to 150 percent redundancy. Still being considered is a further safety factor—a backup battery system. The fuel cells will have far more capability than the expected average power usage of 1700 watts. There will be two cells with three stacks each.

—Hardware fabrication may still be delayed for some time. Grumman expects to spend the next three or four months in further study of LEM and its systems.

• **Longer stay**—Turning to the *Apollo* flight, Canning said LEM would be capable of remaining on the lunar surface for 48 hours for planning purposes. He said a requirement for a lunar landing stay time of 20 hours has been established. Earlier, NASA officials had been quoted as saying the stay time would only be about four hours.

The total mission will take about 160 hours—just short of one week, he said. All systems will however, be programmed for two weeks.

On the flight to the Moon, the *Apollo* will spend about three hours in in Earth orbit, 62 hours from Earth orbit to lunar orbit, and three to five hours in lunar orbit before the landing is attempted. Total flight time will be 70 hours each way plus the 20 hours on the lunar surface.

Canning said one major change has recently been made in the flight plan. Originally, it called for LEM, shortly after separation from the third stage of the *Saturn V*, to swing from its position behind the Command and Service Modules to the front of the spacecraft. This has now been changed: the Command and Service Modules—which will be manned by the three-man crew—will make the switch from in front to the rear of the unmanned LEM.

Currently, he said, the suborbital test flights of LEM with the *Little Joe* booster are expected to reach an altitude of several hundred miles. He said it is also planned to make one manned lunar orbital flight with the LEM. During that flight, the rendezvous portions of the flight will be practiced and reconnaissance of the landing site will be made. ⁂

No firm policy yet . . .

DOD Considering New Profit Guidelines

Logistics Management Institute's weighted system for contractors expected to get close attention

by Frank G. McGuire

USE OF THE WEIGHTED system of guidelines for determining defense contractor profits has been proposed by Logistics Management Institute after a study of Pentagon profit and fee determination policies.

Although not yet Defense Department policy, the recommendations in LMI's report are certain to get close attention, since the Institute was set up by DOD specifically to provide solutions to problems of this type. The study was requested by DOD.

"There is no distinct complete statement of DOD policy on the subject of contract target profit objective," the LMI report noted, adding that such a statement is needed.

It recommended a number of steps to improve negotiation of defense contracts. At the same time, it said that existing Armed Services Procurement Regulations (ASPR) are an adequate basis for a guideline to help procurement officers arrive at more rational profits for industry.

Asked if the new system might significantly affect the workload of the Renegotiation Board, an LMI spokesman had no comment.

Under the proposed system, the weighted guideline system of determining profit or fee would apply only to those negotiated contracts based on cost analysis, and would use the existing ASPR as a foundation.

The system would create among contracting officers an awareness that various procurement situations require differing considerations of what is a fair and reasonable profit. The system is based upon a return-on-investment approach, in terms of what a contractor will contribute to total performance of the contract, and would establish a wider range of profits on prime contracts.

• **Profit deprivations**—"The target profit objective might be defined as that part of the contract price which is in excess of the contractor's costs as recognized by the contracting officer," said the LMI report.

"The objective is to have procurement personnel analyze each individual procurement on the basis of the cost analysis and arrive at a target profit objective which is rational and equitable for that particular procurement." In past cases, LMI found, "a prevailing attitude was evident among procurement personnel that profit should be as low as possible."

• **Weighted guidelines**—The LMI report was critical not of the ASPR as such, although improvements are called

Five Firms Bidding in AF Big Solid Motor Program

FIVE MISSILE/SPACE FIRMS are competing for contracts in the AF big solid motor program.

The companies—Aerojet-General Corp., Thiokol Chemical Corp., Lockheed Propulsion Co., United Technology Center and Rocketdyne Division of North American Aviation Inc.—submitted their technical proposals on Feb. 15.

Two firms on the bid invitation list—Atlantic Research Corp. and Hercules Powder Co.—did not submit proposals.

Cost proposals from the bidders are due Feb. 25 at Air Force Systems Command. The procurement schedule calls for an AF decision in mid-March, DOD review and the official announcement of the selected contractor or contractors in early April.

Four separate tasks were laid down in the AF request for proposals, but the AF has not announced whether a single contractor will be selected for each, or if a single firm may be awarded more than one of the contracts. AF officials have declared that no single prime contractor will be selected for the project, which calls for static-firing of varying-length 156-in. and 260-in. solid motors (M/R, Dec. 24, p. 19).

• **Gimballed concept**—In a related development, one of the bidders, Lockheed Propulsion Corp., announced that a low-cost omnidirectional, gimballed nozzle concept under advanced development weighs only one-eighth as much as a fluid injection system with the same heavy side loading capability.

"Use of this nozzle could reduce the gross weight of a large rocket motor by 20,000 lbs. or more," says G. R. Makepeace, technical director of the Lockheed Aircraft Corp.

The free-moving nozzle deflected the stream from a subscale test rocket ±9° in both the pitch and yaw planes. The test unit was fabricated from state-of-the-art materials and used Lockheed's Polycarbutene R propellant.

The key to the LPC gimballed nozzle is a unique differential hydraulic seal which prevents excessive heating of the apparatus. During the test, Makepeace says, the temperature inside the seal stayed below 300°F while the firing reached a burn period of 165 seconds at an average pressure of 550 psig.

The nozzle is attached to a ring with pinions at opposite axis, much the same as a gyro-compass. Hydraulic pistons, driven by the motor's integral power source, actuate the unit in the pitch and yaw planes. Deflection is caused by the turning of the nozzle itself.

The gimballed nozzle went from design to test in three months. LPC is preparing plans for testing the concept on larger-scale hardware. Lockheed spokesmen say the gimballed approach is superior to current secondary thrust vector controls when large vectoring angles are needed. The liquid-injection vectoring systems become less efficient in a weight sense as the degree of thrust deflection increases.

A full-scale metal mockup of a 156-in. motor was recently run through operational facilities tests by LPC at its Redlands, Calif., processing plant.

As a result of the run-through, the firm is satisfied with its ability to process and test-fire 156-in.-dia. solid motors.

for, but of their application. Inconsistent, arbitrary and irrational decisions and contractual arrangements made under the vague terms of the ASPR are the prime targets of LMI's approach.

The institute deplores the "general prevailing inclination to reduce profits," and advocates adoption of the basic principle of rewarding efficient performance and penalizing poor performance.

The approach viewed by LMI as most practicable and equitable involves a percentile method of application to each cost item, which, when applied to the individual item of cost, results in an amount of fee which can be used as the target profit objective. These percentile ranges are related to the nature of the work involved and are a measure of how much the contractor himself is expected to contribute to total performance.

"This approach," says LMI, "reflects the extent of expenditure of the contractor's own talent and know-how and the utilization of his own valuable resources." This includes:

—*Contractor's input to total performance:* Provides for reward of firms using own initiative, resources and money, rather than acting merely as a job shop. Included are six major subcategories:

1) Material, including direct material, purchased parts and subcontracted items: includes consideration of whether the contractor uses off-the-shelf items or develops entirely new sources of material to provide a better product; consideration also will be given to the contribution of the subcontractor and of the managerial effort necessary to administer the subcontract; and similar factors.

2) Engineering Labor: includes evaluation and determination of the comparative quality and level of the engineering effort involved.

3) Engineering Overhead.

4) Manufacturing Labor.

5) Manufacturing Overhead.

6) General and Administrative Expenses.

The degree to which a contractor accepts contract cost risk will weigh on the negotiations, reflecting "the determination of the Department of Defense to shift the risk of contract costs against contract performance to the fullest extent practicable from its procuring agencies to their contractors and to compensate these contractors for the assumption of contract cost risk."

The LMI report emphasizes that this factor includes only the risk of contract costs and any other risks are a separate problem. For example, such contractor risks as damaged reputation, loss of commercial markets, loss of potential profits in other fields, or any procuring agency risk such as the failure to acquire an effective weapon are not part of this factor.

—*Record of contract performance:* "Proven successful defense contractors should receive more favorable profit consideration than others." As a subsection to its recommendations on profit factors, LMI gave the following list of considerations for evaluation of a firm's past performance:

1) Stability and competence of management.

2) Cost efficiency.

3) Reliability of cost estimates.

4) Timely deliveries.

5) Product quality.

6) Extent and nature of contractor-initiated research.

• **Selected factors**—Other considerations entering into particular procurement situations are also recommended for contemplation by contracting officers. These include an analysis of how much the contractor depends on the government for assistance in the form of progress payments or loans; material assistance in the form of equipment or facilities; and technical assistance in the form of designs, processes and techniques developed by or for the government at government expense.

Special achievement under tight time or performance conditions will be rewarded under LMI's proposal, which calls for an extra profit allowance when outstanding performance is requested. This "special achievement" could take the form of a technical breakthrough; a fast delivery; the divulging of complex know-how of a proprietary nature to new sources on a crash basis; or the effective management of a program which will reduce costs. ⌗

Official Says AF Won't Get MOSS

A TOP Administration official says it is almost certain that the Air Force will not get approval for its own *Manned Orbiting Space Station* program.

The official also told MISSILES AND ROCKETS that the National Aeronautics and Space Council will meet later this year to decide which federal agency should have management responsibility for the project.

He predicted that the program will be awarded to NASA. But he added that one useful alternative to the conflicting AF and NASA requirements for the station might be a joint program similar to the recently concluded NASA-AF agreement on *Gemini*.

In that program, NASA is responsible for development of the spacecraft, but the Air Force will be permitted to participate in later stages.

While both AF and NASA have been calling for a *MOSS* program, neither has yet received top management approval for development funding. In both agencies, the idea is still largely in the concept and study phase.

• **Civilian specs** — Meanwhile, NASA's Manned Spacecraft Center has revealed design details of two *MOSS* concepts for which it will shortly award study contracts for required equipment.

Twenty-two firms have submitted bids for study of the electrical power system requirements, and MSC has requested that proposals for an environmental system for the stations be submitted by March 13.

One station looks like a three-bladed airplane propeller. The hub provides a docking place for spacecraft bringing men and supplies to the station. Scientists and engineers would live and work inside the three arms, each about 75 ft. long and 30 ft. wide.

Each of the three arms would have essential food, oxygen, and waste-disposal facilities for a normal crew of six and a maximum of 12 men—or a total of 36.

The station would rotate slowly, providing artificial gravity for the crews. The hub would have no gravity, permitting zero-g experiments.

The station would be launched from Earth aboard a *Saturn* rocket, unfold in space, and orbit Earth at altitudes ranging from 200 to 300 mi.

This MSC concept calls for a lifetime of one to five years for the station. It would have nearly 30,000 cu. ft. of living space.

The second station proposed by MSC would have no artificial gravity. The station itself would resemble a large rocket, possibly constructed from one of the huge fuel tanks of a *Saturn* rocket.

The station would have 50,000 cu. ft. of working-living space. Drawings provided with the procurement plan show the rocket-like station divided into five or six circular rooms. Spaceships with men and supplies would dock at the pointed end of the station, and new crewmen would crawl into the station through a tunnel.

Crewmen would live in a "shirt-sleeve" environment, donning pressure suits during emergencies or when returning to Earth.



Acquisition



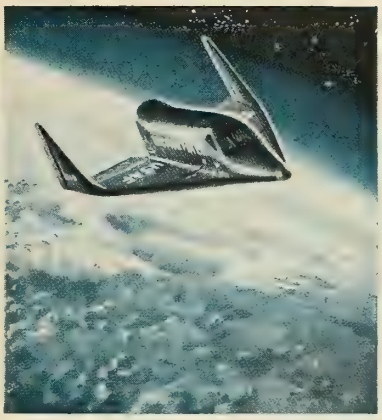
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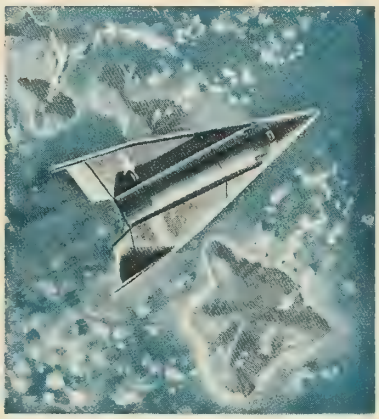
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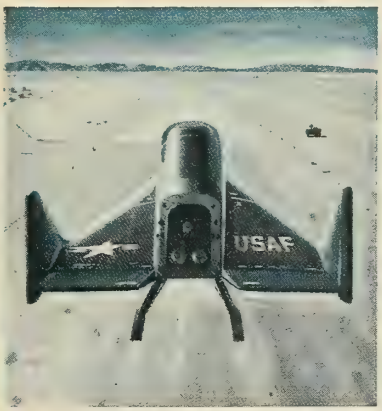
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THE YEAR OF THE QUIET SUN

...AND WHAT DOUGLAS IS DOING ABOUT IT

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Preparation for the Year of the Quiet Sun world scientific survey is one of more than 500 research projects that are under way at Douglas. Some of these relate to the solution of problems on programs of today and tomorrow. Others range through development and research programs whose effects may not be evident until ten or twenty years in the future.

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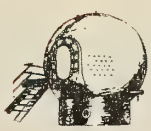
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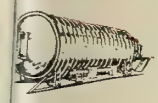
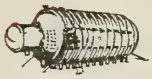
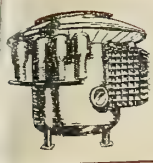
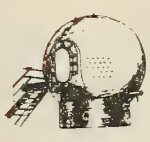
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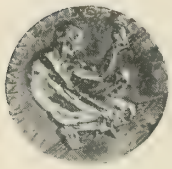
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'Incomparable contributions . . .'



Von Karman Wins Science Meda

President makes presentation; in exclusive M/R interview, scientist hopes for world space effort, questions need for lunar landing

THEODORE VON KARMAN, recipient of the first National Medal of Science, has expressed hope that international cooperation will characterize the next phase of space exploration.

Von Karman, who was given the medal by President Kennedy at a White House ceremony last week, told MISSILES AND ROCKETS the military aspects of space are very important, but that anyone who has a broader view believes space research can only be carried out, with any hope for real success, if all nations work together.

One of the moving forces behind Aerojet-General Corp. in its early years, von Karman has won a long list of awards from American and European universities and governments. He is currently chairman of the Technical Advisory Board of Aerojet-General, and chairman of the NATO Advisory Group for Aeronautical Research and Development (AGARD).

Born in Budapest, von Karman became a U.S. citizen in 1936. From 1930 to 1949, he was director of the Guggenheim Aeronautical Laboratories of California Institute of Technology.

Aerojet and CalTech officials were among those attending the ceremony.

In presenting the medal, created by a 1959 act of Congress, the President called von Karman "one of the pioneers who has helped to make this new and exciting world possible." He said he knew of "no one who more completely represents all the areas of work" described in the authorizing act.

The citation accompanying the medal said the Hungarian-born scientist "has made incomparable contributions not only to the fields of applied mechanics, aerodynamics and astronautics, and to education in general, but also to industrial, national, international and human affairs in their broadest sense."



VON KARMAN receives medal from President Kennedy. Others in photo include Air Force Chief of Staff Gen. Curtis Lemay (between Kennedy and von Karman), Dr. Lee Dubridge of CalTech (partly obscured), Aerojet president William E. Zisch (right).

(While in Washington for the presentation ceremony, Dr. von Karman was interviewed by M/R Senior Editor William Beller and Associate Editor Frank G. McGuire. Highlights of the exclusive interview are presented below.)

'Military Safety . . . and Cooperation with Russian Science'

Q. *Can you give us any extrapolation of your famous "Horizon Report," which had such a fundamental impact on U.S. research and development? Can you see any other recommendations you would make in order to further increase our scientific standing in the next decade?*

A. It is very hard now to say what is in the future, and even much harder to say what the United States should do, because it is a more complicated situation. At the time of the Horizon Report there were certain technical ideas and feasibility was evident; second, there were not such terrific expenses involved; and third, the political situation was not so complicated. I am mostly interested now not so much in the aero but in the astro, and my hope is that I will see the cooperation of all nations. I agree that it is very important to consider the military aspects of space, but I think that almost everybody who has a broader view believes that space research can only be done—with hope for success—if all the nations which are able to work on such things work together . . . and that is a great problem. The difficulties include maintaining military safety as close to 100% as possible, and at the same time have cooperation with Russian science instead of a race.

Q. *What do you foresee that cooperation among all nations can do in terms of a world space effort?*

A. There are several things; many chapters of science can be promoted by such cooperation, and there are also

many practical things. In the few years that we have been working on space observations, for example in astronomy, we have made great progress. Geophysics has also made great progress. Now, you can say that the average citizen will not care what the real shape of the Earth is, but, after all, these are matters of intellectual curiosity. Two things which have immediate application are meteorology and communications. However, like the German astronomer Saliger, I will liken the situation to that which existed in astrology, which was not a science until the principles of mathematics and physics were applied and then it became astronomy. I will wait until meteorology becomes meteoronomy. There is hope for that. Now these have great military importance, too, because there are two things: weather forecast and modest weather control. There are now certain proposals for very serious thought on this. One is that NATO establish a meteorological research center.

Q. *Do you envision such a research center striving for data to turn meteorology into meteronomy?*

A. Yes. And this would be part of a world cooperative view in which we would cooperate with a similar center in the USSR.

Q. *What do you foresee for communication satellites?*

A. The possibilities there are quite fantastic. I've seen calculations showing that if the telephone and telegraph traffic increase as much as in the past few years, it will be necessary to make new communications lines, and if that comes about, it will actually be cheaper and more efficient to establish a satellite system than to lay a few cables. Now, there are political difficulties, because you wouldn't want the system disturbed. Also, there is the question of whether it should be operated by private industry, the government, or an association of governments.

Q. *Do you think the ultimate system will be three synchronous satellites, or the lower-altitude satellites?*

A. A 24-hour satellite system would be better, but it is more difficult to keep exact. It seems a 12-hour satellite is a good compromise with the present state of the art.

"Spending will probably double in next ten years"

Q. *How do you foresee the emphasis on space research? Do you expect more money to be spent on it continuously?*

A. I think so, yes. I don't think this will go on into infinity, but for the coming years it will be necessary. I think the level of spending will probably double in the next ten years, mostly because we are getting more ambitious. Right now, I think we have to find out if landing on the Moon is the right direction to take . . . also, if we should use manned or unmanned machines. I am not convinced that the Moon landing is so important, or if the job can be done by orbiting laboratories. I am very much convinced that man is necessary. The question is whether man can direct the whole affair from a craft, from the Earth, or if a landing is required. In the International Astronautical Federation's Academy, of which I am director, we have formed a committee called the LIL Committee—Lunar International Observatory—and we are discussing whether we want to make a lunar laboratory and if we should build it on the surface of the Moon or keep it in orbit.

Q. *You say our space effort is getting more ambitious. Do you think we'll send men to Mars and Venus?*

A. Yes, but I am doubtful if we will make excursions to other galaxies soon. These will require new methods, but it will take time. The nuclear rocket will generally be used for interplanetary travel, but for travel to the stars we will need ion or plasma rockets or electromagnetic propulsion.

Q. *Can you give us a time estimate?*

A. I think in 50 years we will have an intergalactic probe. *(Pause)* Look here, I shouldn't say that because you can't check up on me.

Q. *Your past predictions have been checked and found true, haven't they?*

A. Well, I will consider this one from the other side of space. So you must ask a younger man.

"New nations at lower technical levels may slow everything"

Q. *Is there any advice you would give to the younger men who are now making our space policy? After all, you are the father of all this.*

A. No . . . well, at least not the legitimate father. The greatest difficulty I see that coincides with the space effort is the end of colonialism. This is a great problem because if we have 48 new nations who are at a low technical level, that is a danger that may slow everything down. We want real international cooperation, and though it is bad luck for the space scientists, it is unavoidable that these new nations have their freedom and independence coincident with the space effort. We will have to expend a certain amount of our energy, which we otherwise would use in the space program, to bringing up the technical level of these countries. Also, the politicians are not free to tie themselves to international cooperation because they are committed first to making Dark Africa a group of nations.

"That is the difficulty—to persuade the young people"

Q. *In the years since Sputnik I, a lot of new, younger engineers have come into the aeronautical sciences or have converted from other engineering fields. Do you think they have the same outlook, philosophy and traditional spirit the poineers in the aeronautical sciences had? Do you think they are over-specialized?*

A. I think they have the same spirit and philosophy, yes. There is one trouble, and this has to be avoided. There are many people who say: "What is engineering? It is physics, it is mathematics," and so on. I think this is an error. Because these early people—the Wrights and others—recognized that some science is necessary, but they also had the right opinion that the engineer must make not only science, but hardware. The old way of having one engineer design an entire hydroelectric project, for example, was good because it showed that the engineer had to create something. But now there are two changes: it used to be a little mathematics, and a little physics and a lot of design ability; now it is a lot of mathematics, a lot of chemistry, a lot of physics, and so on, but we should not forget that without engineers there will be no real progress. That is the difficulty—to persuade the young people. This is a great problem of education, in my opinion, because we really need all the physicists, chemists and others, but we also really need the creative people—not the inventors, there will always be inventors—who will create hardware. And it is not a shameful thing to create hardware. How the technical universities will solve this is not clear to me.

Q. *Do you believe that the terms "engineer" and "scientist" should be wedded so that eventually there will be only one common term—such as "theoretical engineer?"*

A. Yes, I have strived for that from the beginning. I think they should be brought as close together as possible, and I like that term "theoretical engineer."

Q. *Looking ahead into space research, what do you think will come after the Apollo Moon project?*

A. Peace. And that is worthwhile.



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Technical Countdown

PROPULSION

All Six Apollo Engine Configurations Fired

Successful first firings have been made on all six *Apollo* spacecraft rocket engine configurations within a year of the initial bid requests on the launch-escape unit. Robert E. Field, manager of Service Module Propulsion at North American Aviation's Space and Information Systems Div., said the firings were completed by the following S&ID major subcontractors: Aerojet on the Service Module propulsion engine, Lockheed Propulsion on the launch-escape and pitch-control engines, Marquardt on the Service Module reaction-control-system engines, Thiokol-Elkton on the tower-jettison engine and NAA's Rocketdyne on the Command Module reaction control system engines.

Big Solid Site Operational This Year

The huge solid-fuel rocket plant under construction by Aerojet-General in Dade County, Fla., will be operational before the end of this year, says Vice President Richard D. Geckler. Site preparation is well under way and initial plant building construction will begin at the 75,000-acre water-side tract within a few weeks. The facility is aimed at the big solid program. All initial structures are geared to handle up to 300-in. dia. motors. Advanced planning is also underway to use part of the tract for the development, testing and possible production of large liquid propellant systems. The first buildings will house Aerojet's continuous mix process—with a multi-million-pound-per-month solid propellant capacity.

Subliming Solid Microrocket Under Contract

Rocket Research Corp. will manufacture its solid subliming-microrocket under a contract from NASA's Goddard Space Flight Center. The tiny unit will be used to produce the precise control forces needed to adjust satellites after orbiting. A new type of solid propellant is used, which can be turned on and off at will. The system is free from the usual ignition and combustion complexities. The propellant was not named nor was the contract amount disclosed.

ADVANCED MATERIALS

Aeronutronic Moves Into Motor Case Work

The Aeronutronic Div., Ford Motor Co., intends to establish a market position in the solid-rocket motor business through its research efforts in Ausforming—strengthening steel alloys by plastic deformation in the metastable austenitic condition. The Ford-patented Ausform process is being directed toward producing motor chambers having strength-to-weight ratios in excess of 1.2 million in-lbs. per lb. Aeronutronic has designated the motor case area as a new product field and has named Dr. E. L. Harmon its director. The division has fabricated lab Ausform cases up to 8.8 in. dia., and is currently under DOD contract to develop larger units.

Nickel Alloy Sheet Strengthened

A new process is being used at Ling-Temco-Vought to produce high-strength superalloy sheet and foil in experimental quantities. The company-sponsored process reportedly increases the tensile strength of nickel-alloy sheet materials aimed at high-temperature applications. L-T-V claims high-temperature strengths equal to that previously only available in castings. As an example, INCO 713c has a tensile strength of 50,000 psi at 1900°F, with improved ductility when rolled into sheet by the process. INCO 713c is part of a sheet development program sponsored by the Air Force but the process was developed separately by Chance Vought's Aeronautics Div.

ELECTRONICS

BMEWS Trackers Operational in '63

Installation of the three 84-ft. dia. BMEWS tracking radars at the Fylingdales Moor station in England will be completed and all three will be in operation in 1963, according to RCA. The first operational AN/FPS-49 built by the company is in use now at the Thule BMEWS facility. Although details of the huge dish have never been released by the Air Force or by RCA, prime contractor for the billion dollar BMEWS, the tracker is similar to that built by MIT's Lincoln Laboratory at Millstone Hill near Boston. That radar, also employing an 84-ft. dish, radiates 2½ million watts peak power at 440 mc. The FPS-49 operates in a similar frequency range, but uses monopulse techniques and far greater power. Also it is believed to be more accurate than the Millstone radar, which reportedly is capable of tracking a 3-ft. sphere 3600 miles in space and has successfully tracked objects of missile warhead size over ballistic trajectories.

X-15 To Be Used in Plume Studies

To further extend its missile plume and atmospheric studies, Air Force Cambridge Research Laboratories will employ three new instrument packages in upcoming *X-15* flights. One is a 15-lb. infrared radiometer designed to measure the IR signature of the ammonia-lox engine exhaust and capable of covering the 0.5 to 2.8 micron range. The second is a radioactive ionization gage which, when exposed to ram air, will measure atmospheric density. The target will involve regions above 100,000 ft. altitude. The third is for a micrometeorite collection study of the region above 150,000 ft.

Syncom For Second Generation?

Eugene F. O'Neill, director of the Bell Satellite Communications Laboratory and manager of the *Telstar* satellite program, claimed last week before the Communications Subcommittee of the Senate Commerce Committee that an operational ComSat could be had in 3 or 4 years. Further, he asserted that synchronous types should be considered for a second-generation system rather than delaying development in an effort to obtain the "ideal system." The U.S. and Europe would require 18 satellites in a 6500-mi. orbital system, while 35-40 would be needed for global coverage, he stated. O'Neill foresaw no technical obstacle to satellite communications repeaters having operating lives in orbit of 5-10 years.

Another Radio Blackout Cure Revealed

A spaceborne communications transmitter, operating in the 5-gc band and used with the Azusa tracking system, will overcome the radio blackout experienced by manned vehicles during re-entry, says General Dynamics/Astronautics. The Azusa would be used, says GD/A until spacecraft impact has been predicted. Then, vehicle communications would be switched to voice transmission only through the period of thermo-ionization. The company reports 12 successful flight tests at AMR aboard *Atlas* missiles with no communication failures to date.

Scientists and Engineers: Look to Lockheed for Leadership





INSTANT LAUNCH

Will space vehicles of the future be launched on a ready-set-go basis? "Yes," says Robert A. Bailey, chief spacecraft engineer of Lockheed-California.

"Refinement of current launch procedures is inevitable in the years ahead if we are to achieve greater efficiency for America's space assault. New techniques in spacecraft launching are essential if we are to rendezvous with manned space-based vehicles."

As visualized by Lockheed-California scientists, automatic launching of "flight ready" probes depends on completing a maximum number of pre-flight operations before the spacecraft moves to its launching pad. Mating, assembly, tests and erection would be performed off the launch site. Result? Between-firing periods would be cut to hours instead of days or weeks.

This new concept in spacecraft and missile launchings — rapid-fire liftoffs that meet selected, split-second schedules — typifies the challenging problems that engross the attention of those who work here.

SCIENTISTS AND ENGINEERS of top-level talent and training are invited to explore the immediate openings at Lockheed-California in: Antennas and Propagation; Advanced Systems Planning; Bioastronautics and Space Medicine; RF Equipment; Astrophysics; Communications Analysis; Aerophysics; Tracing, Telemetry, Command Engineering; Weapons Effects; Operations Research; Theoretical Physics; Radar Systems; Dynamics (Flutter, Aeroelasticity); Thermodynamics; Flight Test; Guidance and Control.

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SMS Satellite Program Under Way

Republic studying potential of high-altitude system; sensor, stabilization demands critical

by Michael Getler

FARMINGDALE, L.I., N.Y. — NASA-supported systems studies now in progress at Republic Aviation Corp. here should help the space agency draw up a broad approach to development of a *Synchronous-altitude Meteorological Satellite (SMS)*, to be launched sometime in the 1966-68 time period.

Results of the four-month, $136,640 study (M/R, Feb. 18, p. 11) will be presented to NASA in late May. They will outline design parameters for several differently configured payloads of 100, 500, and 1000 lbs.—weights based on use of *Thor-Delta, Atlas-Agena,* and *Atlas-Centaur* boosters, respectively. All payloads will include apogee "kick" motors for the synchronous orbit maneuver.

The study data, the growing NASA in-house effort, and design and operating experience with current inclined-orbit *Tiros* and future polar-orbiting *Nimbus* weather satellites should provide a very broad base in this technology. Experience with *Syncom* ComSats will also aid logical development of *SMS*. If an *SMS* flight program is approved, NASA could then elect to act as program manager, much as it has for *Nimbus*. Award of a systems integration contract and individual awards for various systems would then flow through NASA's Goddard Space Flight Center.

Development of long-lead-time systems, in particular new sensor equipment, could begin late this year or early in 1964. First experimental launching probably would place a single satellite into a near-synchronous (22,240-mi.) orbit positioned equatorially at 90° W. longitude.

• **Day/night cloud cover** — The *SMS* study is aimed primarily at outlining requirements for providing high-resolution day-and-night cloud-cover data and IR measurements of the Earth's heat budget or radiational patterns from the synchronous altitude.

Much of the hardware and techniques believed to be needed already are within the state of the art. Major study efforts will be directed at disclosing possible improvements in sensors which will yield desirable image resolution from the 22,240-mi. level.

Of prime importance will be *SMS* ability to watch weather developing continuously, as opposed to the 3-4-hour viewing and reporting interval common to lower-altitude systems which may pass over a region of interest only once each orbit and then must store data until a pass over a retrieval center. Republic project manager Earl McLaughlin says the study will determine requirements for data transmission at least every 30 minutes, also to frequencies as rapid as every 30 secs.

One *SMS* should be able to observe about ⅓ of the Earth in about 55 million sq. mi.—in a single view as opposed to a 450-1500-mi. area estimated for the *Nimbus* sensors. Actually, an estimated 28 million sq. mi. of *SMS* viewing would yield usable data. The mosaic construction difficulties of smaller-field-of-view systems are virtually eliminated. On-board data storage problems would be eased, if not completely removed.

• **Time advantages** — Real-time or near-instant readout also allows cloud pictures to be monitored and repeated if deficiencies are observed. This same advantage may remove certain on-board computer requirements for attitude stabilization, allowing ground-based computers, acting through a command link, to handle the job rapidly.

Also of impotrance is the availability of time with which to transmit data. Rather than a 10-15-min. fly-by over a data center, the stationary *SMS* transmission time is limited only by the repetition rate desired. Furthermore, Republic points out, time is available to adjust data rates to the available bandwidth so that no restrictions on resolution are imposed by the sensor data link.

Difficulties inherent in *SMS* grow basically out of the admittedly severe problems of imaging from long distances to meet resolution demands, and from dynamic range demands on sensors that see both day and night portions of the Earth in a single view and will be affected by sunlight entering the optics at certain angles which might damage photosensitive surfaces.

Republic will study various filtering and shading schemes for the optics, and also will investigate the possibility of using a single advanced-type sensor for both day and night cloud-cover surveillance. For this application, the study will center on improved image orthogon devices, vidicons, and electrostatic tape camera systems. For the IR heat budget measurements, new IR vidicons with improved frequency range and resolution, thermicons, and other IR imaging systems will be explored.

McLaughlin feels that resolution equal to that obtainable with lower-altitude systems will be obtainable during the *SMS* development period through improvements in imaging and stabilization gear and also by new area-scanning methods. The study will probe sensor requirements for resolution from 1/10 mi. to 50 mi. up.

Other development areas include:

—*Ground stations*—Only two main command and data centers would be needed for a global net of four satellites, though other existing satellite stations could be modified to receive *SMS* data. This would mean several stations in line of sight of an *SMS* could receive data without delay. Use of *Nimbus* stations as main centers does not appear likely, due to time-sharing problems. Also, most of the *Nimbus* stations will be in northern latitudes. No large requirement for new ground equipment is foreseen at this point.

—*Altitude stabilization*—All types will be investigated, including some of the more exotic methods which may find use beyond the early flight phase. A three-axis system using gas jets and reaction wheels seems probable for heavier payloads; spin stabilization is likely to be used with the smaller payloads. Earth-horizon sensors are being studied for roll and pitch axis, possibly with a star tracker or Sun sensor used as the yaw axis determinant.

—*Power*—*SMS* is expected to produce a steady 300-400-watt power requirement. Peak power periods common to non-stationary systems should not occur, Republic reports. Solar cells may be the logical choice to supply the power, although, as with other subsystems, a wide range of alternatives are under consideration. At the synchronous equatorial orbit, *SMS* would be out of sunlight for only 78 hours a year, with 67 minutes maximum for any one day. ⌘



RADIATION at Stanford project engineer Roby Blessing is shown with new transformer to be used in upcoming test of extremely high-power radar.

space electronics

'Super-Power' Radar Nears Testing

System being built for ARPA includes Varian klystron tube of vast strength and behemoth RAS transmitter

by Robert Lindsey

PALO ALTO, CALIF.—The most powerful radar system yet developed by the United States will be tested here soon.

Although details are secret, MISSILES AND ROCKETS learned this week that Varian Associates engineers have completed fabrication of hardware for the high-priority "super-power" program of the Defense Dept.'s Advanced Research Projects Agency (ARPA).

Varian developed the enormously powerful high-frequency klystron tube that will be used with a transmitter facility concurrently developed by Radiation Inc.'s subsidiary located at nearby Stanford.

If the system works as planned, the single klystron tube will generate more power than all eight klystrons employed at a single Ballistic Missile Early Warning System (BMEWS) installation.

Frequency, power and application of the tube are secret. But it was learned that the tube will transmit a relatively high-frequency signal with both peak power and average power far above the accepted state of the art. Also, it is believed that a movable antenna will be used.

One engineer claimed that average power required by the radar will be 500 times more than World War II's most powerful radar, and peak power will be 25 times greater. (One reliable source reported that the tube is rated at one megawatt.)

• **Weapon spotter?**—ARPA has reported previously that Varian is working on a super-high-power klystron to be used for detection of "extra-atmospheric" weapon systems, but the company declines comment on the application of the system or whether it has been funded beyond R&D.

The "super-power" system is expected to be extremely efficient at identifying relatively small objects at great distances. And, since its echo will be stronger, it should help make identification of objects in space easier than with a conventional system.

Varian and Radiation at Stanford have had parallel programs under way for more than two years. The prototype installation is now virtually complete and tests will begin soon.

Radiation from the tube will be absorbed by the test facility. Dealing with the high power and high voltages of the system has required construction of behemoth support facilities. The test complex requirements were so big it was necessary to build a separate building at the Varian plant. The transmitter alone fills one 50x50x50-ft. room and another 50x30x30 ft.

The system can be tested only at night because the energy required consumes one quarter of the electric power available from the city of Palo Alto.

Albert Morris, president of Radiation at Stanford, estimates the system will be "by far the largest transmitter facility in the world."

Commenting on increasing demands for power in space communication and weapon programs, he forecasts that "we are at the dawn of a new era. We are handling higher powers at higher frequencies than ever before. We're getting into areas where we've never been."

The super-power program, he said, required major state-of-the-art advances in virtually all phases of transmitter technology. Innovations were necessary simply to package the enormous transmitter. Safety precautions were necessary beyond any previous system because of the high voltage. RAS built the power supply, modulator and cooling system for the transmitter, which comprises virtually all of the system except the klystron tube itself. ⁂



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Thiokol's Wasatch Div. employs high-pressure water jet method to slice solid propellant from motors

by Richard van Osten

BRIGHAM CITY, UTAH—An up-dated version of old-time placer mining technique is being used to reclaim cases for big solid-propellant boosters at Thiokol Chemical Corp.'s Wasatch Division.

Based upon high-pressure water jet principles, the process will save the Air Force approximately $80,000 in hardware "gold" for each first-stage *Minuteman* motor case recovered.

Formerly, removing defective propellant grain required either static firing —destroying the hardware—or a soak-out with solvents. The latter process is something less than practical because of the resistance of polymer-based solid propellants to solvents.

With the new process, it takes about 48 hours to reclaim a first-stage *Minuteman* motor. But this time is expected to decrease with experience in using the system.

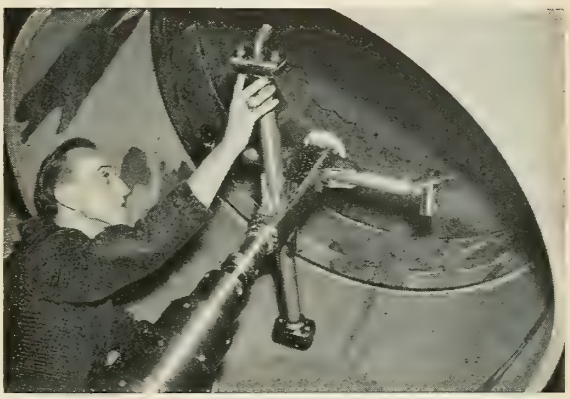
• **Operation**—In the Thiokol process, a loaded motor is rolled onto a rail-equipped tilt table and secured. The initial cutting operation is made by a water jet fixture inserted through the motor's nozzle ports to remove insulation and bonding material at the aft closure-to-case joint. A hydraulic wrench is used to detach the aft closure.

Both table and motor are then tilted to a 30-deg. angle, with the motor's aft end down, and a revolving telescopic boom with four spray nozzles attached to its head is moved into the first cutting position at the case's aft end. A spray shield encloses the case's aft end and the water nozzles.

Primary water supply is a 5600-gal. storage tank which feeds a high-pressure pump through a 6-in. pipe. A 2-in. pipe carries water from the pump up through the center of the telescopic boom to the nozzles at a flow rate of 150 gallons per minute and at pressures up to 6000 psi. The pump is driven by a 600-hp electric motor through an eddy current coupler and gearbox.

When the water reaches the desired cutting pressure, the nozzles are slowly rotated 360 degrees across the face of the propellant grain. The nozzles are so angled—with matching angles in nozzle pairs mounted 180 degrees apart on the rotating head—that the water pattern intersects at a point within the propellant for a maximum cutting effect.

After the first revolution has been completed, the boom is advanced into the case from three to five inches. The nozzles are again rotated at speeds varying from one to three revolutions per minute —depending upon the solid content and the propellant's modulus of elasticity. During this cutting phase, the water streams take a bite of about nine inches into the propellant.



WATER NOZZLES producing a jet force of 6000 psi at 150 gallons per minute are indicated by a Thiokol process engineer.

This sequence is repeated until the boom and the cutting nozzles have covered the length of the case. Then the boom and nozzles are retracted from the case and the nozzles attached to extensions to move them farther from the boom centerline for a wider bite into the grain. This procedure is repeated until all propellant and insulation have been cut from the case interior.

As the propellant is cut, water and the propellant pieces drain from the tilted motor case to a vibrating conveyor—another carry-over from gold-mining techniques. The water drops through the screen, leaving only propellant chunks on the conveyor. A second screen filters very small particles and general residue from the water. The water is then routed to a settling tank from which it is pumped to a 500-gal. surge tank and from there back to the basic storage tank for recycling.

Waste propellant is automatically conveyed to bins outside the reclamation facility building. When full, the bins are transported to a propellant dump where the propellant is burned.

All reclamation operations are conducted and monitored from a remote bunker by a manual control system. The controls, however, are designed in a cascade pattern restricting operation to a proper sequence. Instrumentation in the control room indicates any equipment failure and automatically stops the operation. Closed-circuit TV allows visual monitoring of the process.

• **Wider uses**—The concept will scale without difficulties, Thiokol engineers say. Larger systems would require some variation in nozzle design, but the overall approach would remain the same. Primary changes would be an extension of boom length and an increase in table load capacity.

The system may also be used on large solid motors with filament-wound cases. To avoid damage to the case, however, changes in nozzle design would be necessary—primarily to modify the cutting angle of the water streams. It would also be necessary to change the water pressure used. This would require a longer cutting time for a given propellant type. It is hoped that the present 48-hour removal time for the first stage *Minuteman* case can be reduced to about 24 hours.

Although the company is not anticipating production of *Minuteman* first-stage motors with flaws in the propellant, reclamation of only seven such motor cases will return the $500,000 investment in the facility. An even bigger pay-off could come from the recovery of high-cost test cases being developed for very large solid propellant booster programs. ⁂

JPL Developing Advanced Liqu

System would stress extreme simplicity, reliability in powering l unmanned planetary spacecraft; may be operational by end of this d

PASADENA, CALIF.—An engine concept called ALPS (Advanced Liquid Propulsion System), stressing extreme simplicity and reliability, is being developed by Jet Propulsion Laboratory for heavy unmanned planetary spacecraft.

Intended to supply relatively high thrust levels for such maneuvers as retro-thrust into planetary orbit, de-orbit, and planetary landing and take-off, ALPS-based engines are expected to reach operational status near the end of this decade.

JPL work is scheduled to culminate in 1964 with demonstrations of a prototype engine proving the concept. Design and manufacture of operational engines will be contracted to industry. The engines are expected to find many applications over a long period of time.

JPL has assigned 20 engineers and technicians to the project and is funding it at the rate of $1 million per year.

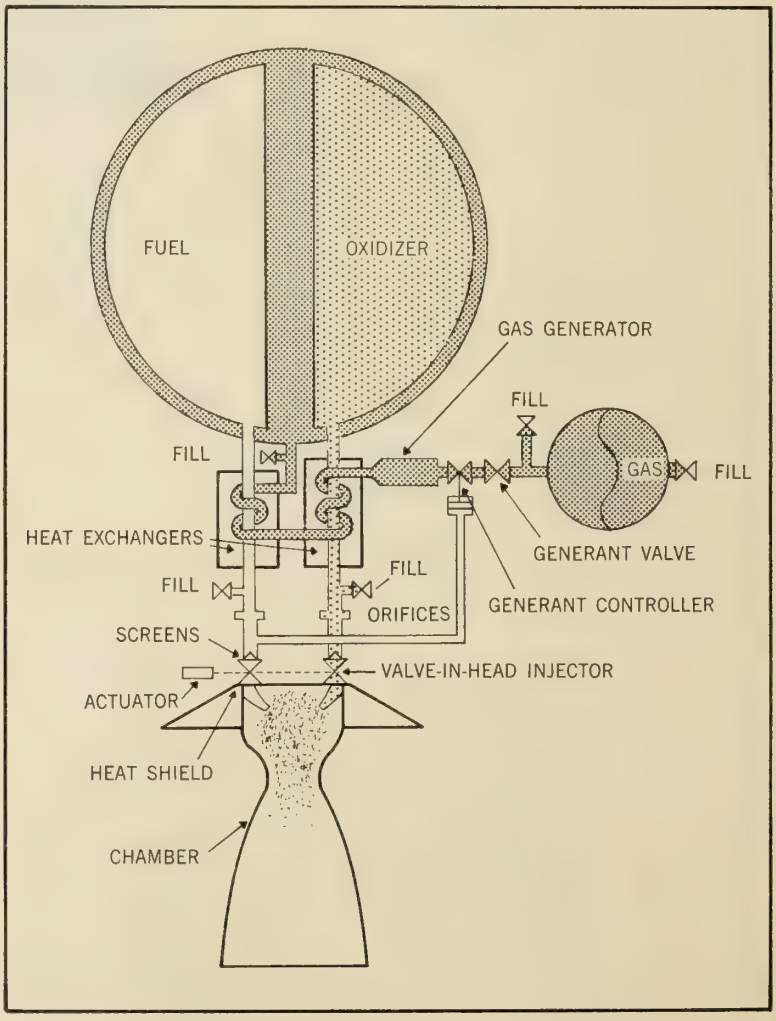
Engines using proposed ALPS technology are already undergoing static test firings on JPL test stands at Edwards AFB, Calif. One test engine develops 2000 lbs. of thrust—the other, 100 lbs. The final prototype is expected to produce approximately 7000 lbs. of thrust

The thrust of engines developed under the ALPS concept will be controllable for use in low-thrust maneuvers, such as mid-course guidance corrections and orbit trimming, as well as high-thrust maneuvers.

• **Reason why**—The concept is being designed to a JPL requirement for reliable unattended starts after a one-year coast through space. A requirement that the system be able to withstand high-temperature sterilization with full propellant tanks may be imposed later. The ALPS concept is thought to be comparatively adaptable to this, though tank walls would have to be thicker and an oxidizer with relatively low vapor pressure, such as red fuming nitric acid (RFNA), would have to be used.

While mechanically simple, ALPS is very demanding of materials technology and makes use of some untried processes. JPL engineers are quick to admit that they have not accomplished all the ambitious component developments required for ALPS. However, they think the program may produce the answers. Some component tests already are promising success.

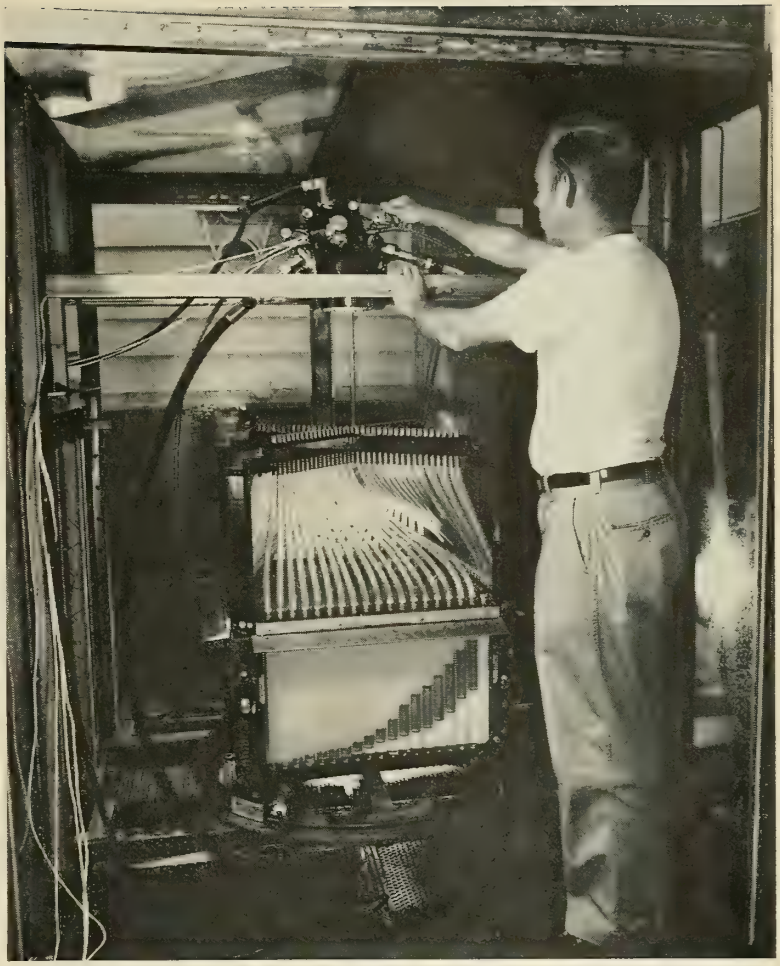
The high-level thrust maneuvers for a one-way mission to Mars or Venus call for about 1000 sec. of run time to provide a velocity increment of about 10,000 fps. Retro-thrust into a planetary orbit alone requires 10 to 15 times the total impulse needed for such low-thrust maneuvers as mid-course corrections; the engine for the job makes up about 65% of spacecraft gross weight compared to less than 10% for low thrust maneuver engines.



SCHEMATIC of Jet Propulsion Laboratory's ALPS engine.

gine Concept

by Russell Hawkes



A 200-LB. THRUST injector is shown after test to determine spacial distribution of mass and mixture ratio. Non-burning fluids simulate fuel and oxidizer. Device pivots on track (bottom) to sweep simulated chamber area in successive tests. Injector system is used in studies of Advanced Liquid Propulsion System program at Jet Propulsion Laboratory.

• **Approaches** — JPL's ALPS staff, seeking the simplest design that would provide the required versatility, began with certain preconceptions about what constitutes maximum simplicity in a liquid propellant engine. They are attempting to incorporate these preconceptions in the prototype system and compromising reluctantly when compelled by the limits of technology.

The goal is a pressure-fed bipropellant system with only three control components, of which only one must respond directly to guidance and control system commands. The lack of propellant pumps and the reduction in the number of control elements which must be coordinated contributes heavily to reliability.

The plan is to use Earth-storable propellants, because payloads will generally require Earth-level temperatures. The fuel finally chosen will probably be one of the hydrazine family and the oxidizer will probably be nitrogen tetroxide or mixed oxides of nitrogen. The chamber will be cooled by radiation or ablation to avoid the problem of propellants trapped in the tubes of regenerative cooling systems during long coast periods. JPL engineers appear to have a slight bias in favor of radiation cooling, but final selection of the cooling mode must await the outcome of further study and research.

Propellants are to be stored in separate bladders within a single pressure vessel and expelled by the pressure upon the bladders of cooled exhaust gases from a monopropellant decomposition chamber. An alternative arrangement would be to divide the tank by two flexible diaphragms between which pressurizing gas would be introduced. A single spherical pressure vessel fits well with optimum spacecraft geometry, and halves the possibility of plumbing troubles.

As yet, no material has been determined to be suitable for the bladders. Teflon is sufficiently inert, but ALPS engineers suspect it is too permeable. There is no flight experience with Teflon bladders, but JPL is conducting tests. The ALPS staff is interested in new composite materials that might meet their requirements.

JPL is seeking a spontaneous catalyst for a hydrazine pressurizing medium to eliminate the need for a starting slug of oxidizer. A packed bed of metal carrier pellets clad with a reactive metal is being developed for the project by Shell Development Co.

• **Workings**—The main engine control of ALPS consists of propellant throttle valves that are an integral part of the injector. The small line volume between the valve and the injector face eliminates slow-thrust decay after shutdown. A tank pressure regulator measures propellant line pressure and governs hydrazine flow in the gas generator to maintain the desired level.

A generant shut-off valve is installed as a safety measure to prevent the propellant tank from being overpressurized by a leak in the generant regulator. The throttle and shut-off valves are the only engine components that respond to signals from a guidance and control system.

A gas-to-propellant heat exchanger will be used to reduce the temperature of the pressurizing gas from 1800°F at decomposition to 150°F in the propellant tank. The best combustion chamber pressure for ALPS missions will be low—between 100 psi and 150 psi. Theoretical flame temperature for the propellants being considered is about 5000°F. JPL has tested a single-throttle element injector for the engine—with only fair results. Other designs are being worked out.

The favored idea for thrust-vector control is engine gimballing. However, for some applications three-chamber propulsion systems are being considered; in this case, thrust vectoring could be handled by differential throttling of the engines. ⁂

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missile propulsion

Aerojet Methods Help Boost Polaris Range

SACRAMENTO, CALIF.—A substantial part of the 2400-mi. range of the *Polaris A-3* missile results from a mixture of high-energy, nitro-aliphatic compounds pouring out of a new $4.6-million continuous-process plant at Aerojet-General Corp. here.

The nitroplasticizer is credited with providing a more dense propellant grain —plus an increased I_{sp}—in the volume limited *Polaris* system. The nitroplasticizer ingredients allow room-temperature curing of the motor, and there is some indication the nitro-aliphatic-type propellant tends to expand during the cure —solving problems in the grain-to-insulation-to-case binding areas.

The process is adaptable to other motors, and there is a possibility of consideration in the *MMRBM* and other later programs. Specifications on the upcoming 260-in. solid development program eliminate the nitroplasticizer, but Aerojet spokesmen say there might be a requirement later—depending of what missions are assigned to the large solids.

Constructed entirely with Aerojet funds, the plant resulted from a far-sighted research program on nitro aliphatics initiated in 1947 at the firm by the Office of Naval Research, with subsequent support from Navy's Special Projects Office.

The high-energy compounds are a mixture of *bis* (2,2-dinitropropyl) formal and *bis* (2,2-dinitropropyl) acetal produced for the Navy on a fixed price basis. The choice of the formal and acetal was based on considerations of stability, manufacturing ease, improved propellant performance, properties and processing.

The key intermediate in the process is 2,2-dinitropropanol. Aerojet chemists investigated two routes to synthesize it—one a high-yield oxidative-nitration reaction discovered by Kaplan and Schechter in an ONR-sponsored program at Ohio State and the other based on the ter Meer reaction. The latter is a four-step procedure starting with commercial nitroethane.

• **Cost-dictated technique**—The continuous plant follows the ter Meers route because the oxidative nitration procedure involves heavy silver losses —an economic drawback. In addition, the development of continuous processes for silver recovery and silver nitrate regeneration without complex and expensive equipment seemed a dim possibility.

Attention focused on the chloronitroethane route for economic reasons. The four steps involved are neutralization, chlorination, replacement of chlorine by a nitro group and methylolation —with chlorination posing the principal problem.

The nitroacetal is then prepared by treating the alcohol with paraldehyde and boron trifluoride, and the formal by reaction of the alcohol with trioxane in the presence of concentrated sulfuric acid.

In batch systems, the main side reaction product from the chlorination reaction is 1,1-dichloro-1-nitroethane, formed by two paths—one involving an aci conversion of the nitroethane with a base resulting in a high pH solution and the other a salt interchange. Both reactions are extensive in batch processes, tending to produce low yields of 78-88% pure product.

The Aerojet continuous process includes a single-stage agitated chlorinator, which maintains a slight excess of chlorine, giving a pH of 3-6. Under these conditions, the reaction of chloronitroethane with base is eliminated and the salt interchange route is greatly reduced through certain increased reaction speeds.

• **Pilot plant adapted**—Adapting the existing batch-process pilot plant for the formal to continuous operation presented little difficulty—with yield and conversion being 95% and 90%, respectively. The same adapting ease held true for the acetal batch process conversion after the development of a new process. Yield and conversion were 90% and 75%, respectively.

Aerojet spokesmen would only state that the production rates were substantial and costs reasonable. The process design is based entirely on lab results from continuous bench-scale studies.

The production facility is almost entirely self-contained, having provisions for raw material storage, utilities, waste disposal, equipment maintenance and analytical lab support.

While classed as high-energy compounds, the nitroplasticizers are relatively safe to handle. The hazard level is comparable to that of TNT. ⁂

Stehling Cites Urgent Propellant Needs

High-energy space-storable combinations promising for manned lunar landing program

by John F. Judge

THE EXTREME propulsion requirements generated by manned lunar landing will make certain propellant characteristics mandatory—instead of merely desirable—says K. R. Stehling, of NASA's Office of Plans and Programs.

The propellant must have a high-density impulse, low ignition lag and space storability. High specific impulse and self-ignition are highly desirable.

The most promising propellants available are the high-energy storable combinations—since they avoid the temperature problems associated with cryogenics. But Stehling implies an accelerated effort is needed in high-energy propellant programs, especially in the OF_2-diborane combinations, since preliminary considerations indicate that the latter may be superior to other systems under scrutiny. (M/R, Dec. 11, 1961, p. 22)

The tough propellant requirements stem from the need for zero-g engine start, non-aerodynamic descent, landing and take-off from unprepared sites without the benefit of ground crews, and extremely precise descent and ascent flight paths.

Stehling presents the results of NASA analyses and industry experiments in Technical Note D-1723 covering the propellant combinations F_2/N_2H_4, F_2/H_2, N_2O_2/N_2H_4, H_2/O_2, and OF_2-diborane.

• **System musts**—In his treatment of specific impulse, Stehling says a lunar propulsion system—especially if dependent on a combination such as N_2O_2/N_2H_4—should have:

—A nozzle expansion ratio greater than 40 if an I_{sp} of about 300-330 is to be obtained.

—A low chamber pressure consistent with stability and regenerative cooling criteria.

Stehling emphasizes that a low chamber pressure may not be a panacea, since for a particular thrust level the chamber and nozzle volumes increase with a decrease in chamber pressure.

While specific impulse is the normal method of propellant comparison, the lunar mission might be better satisfied, says Stehling, by using volumetric specific impulse, or density impulse.

Instead of merely comparing performance on the basis of the propellant-engine combination, density impulse brings in the whole aggregate of tanks, engine and propellant. Propellant density is a powerful factor in the velocity and range equations.

Using this basis of comparison, some space-storable combinations surpass the H_2/O_2 system, but Stehling says there are other considerations: toxicity, corrosivity, space storability, sensitivity to combustion instability, cavitation sensitivity, cooling capacity and ignition.

In the OF_2-diborane area, Stehling points to the relative scarcity of experimental rocket data—a factor that can only be alleviated by an increase in experimental firings. Available data on exhaust velocity, equivalence ratios, bulk density and flame temperature tend to be inconsistent.

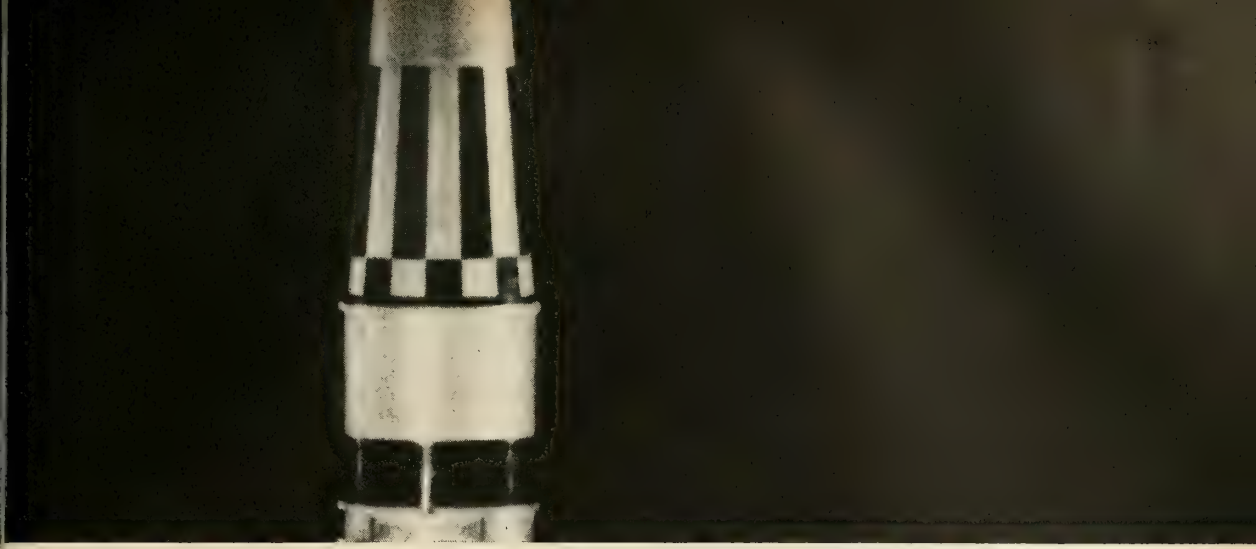
While the OF_2-diborane combination is hypergolic, no consistent ignition delay figures are available. Stehling says the cooling qualities of the two substances are poorly understood and more work is necessary in experimental heat transfer analysis to bolster this.

• **Increased effort needed** — About two to three years of thorough combustion and fluid mechanics research and development work must be done before the combination can be expected to be available for operational systems.

With an approximate bulk density of 1.04 g/cc at −145°C for both propellants and an estimated I_{sp} of 432 sec.—shifting equilibrium and the same conditions as the other propellants considered—the OF_2/B_2H_6 combination has an apparent "quality factor" for relative burn-out velocity superior to F_2/N_2H_2 by a margin of 5 to 10%. ⌗

Comparison of Fluorine and Nitrogen Textroxide as Oxidizers Used With Hydrazine(s)

PROPERTY	F_2	N_2O_2
Toxicity: A problem only if leakage into cabin is possible—a remote possibility with good tank and cabin design.	Serious at over 4 ppm when H_2O is present.	Serious at over 7 ppm. Presence of H_2O is influential.
Corrosivity with Al alloys.	Negligible in dry state. Can be very serious when temperature rises, as in pump seals, or in presence of traces of organic or inorganic impurities.	Negligible
Storability in space (Considering only heat transfer)	Poor → Fair FP:~−218°C BP:~−189°C	Good FP:~−10°C BP:~21°C Experiments with rocket payloads and aircraft indicate 0-g behavior also favors use of a non-cryogenic.
Combustion instability sensitivity	Apparently quite insensitive: F_2/N_2H_4 reaction is characterized by a low combustion time lag (τ) lower than that of N_2O_4. Experience indicates that this benefits stabiltiy.	High-frequency instabilities have been noted, but no serious terminating instabilities.
Cavitation sensitivity: Coupled to the 0-g stage and aggravated by it. Cavitation can be serious in injector domes and feed lines, as well as in pump inlets.	Vapor pressure: 760 mm at −189°C 1 mm at −218°C Rises 759 mm for a 20°C temperature rise.	Vapor pressure: 760 mm at 21°C 810 mm at 50°C Rises 50 mm for a 20°C temperature rise.
Cooling Capacity	Fair only beyond critical pressure. Would require heavy cooling-passage pressures; ablative thrust chambers would eliminate this need.	Good up to saturation.
Ignition characteristics: Liquid-liquid contact assumed. Lag tends to increase as ambient pressure (inside thrust chamber) decreases.	Measured at 760 mm initial chamber pressure: 1.2 msec. Hypergolic, much more reactive than N_2O_4.	Measured at 760 mm: 4.5 msec. Hypergolic.



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Creep-rupture properties of USS Stainless Steels at 1600°, 1800°, and 2000°F

Creep and creep-rupture tests were made on annealed Stainless Steel sheets of AISI Types 302, 309S, 310S, 314 and 316, and 310Cb at 1600°, 1800°, and 2000°F, and on annealed Stainless Steel sheets of AISI Type 446 at 1600° and 1800°F.

In summary, the results of creep-rupture tests and metallographic and X-ray diffraction studies on these steels indicate that:

1. The austenitic stainless steels have, in general, higher creep strengths than the ferritic Type 446 Stainless Steel, although the difference in their strengths becomes less as the temperature is increased from 1600° to 1800°.

2. Type 310S Stainless Steel has the highest creep strength and creep-rupture strength at 1600° and 1800°, whereas Type 314 Stainless Steel has the highest strength at 2000°, probably because of its better oxidation resistance.

3. Sigma phase did not form during long-time testing at 1800°F and 2000°F (but did form at 1600°F) in Types 309S, 310S, 310Cb, 314 and 316.

The accompanying tables contain the data obtained by the testing. We will be happy to furnish full information on request.

United States Steel offers creep and creep-rupture data on a wide spectrum of steels for elevated temperature service. In addition to conducting extensive research into the behavior of steels at elevated temperatures, we produce a full line of high quality steels for use at red heat. If you need data, let our Lab people supply it. And if you want assurance of quality, specify USS when you buy.

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Table 1. Chemical Composition of the Steels Investigated—Percent *(Check Analyses)*

Steel	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cb
AISI Type 302	0.05	1.35	0.031	0.006	0.72	8.5	17.2	*	0.058	*
AISI Type 309S	0.05	1.32	0.024	0.021	0.51	14.8	22.5	*	0.023	*
AISI Type 310S	0.07	1.50	0.028	0.007	0.61	20.5	24.6	*	0.064	*
Type 310 Cb	0.057	1.70	0.021	0.008	0.68	20.9	24.9	*	0.063	0.92
AISI Type 314	0.04	1.48	0.019	0.008	2.15	20.7	24.1	*	0.055	*
AISI Type 316	0.05	1.40	0.033	0.025	0.41	13.5	17.6	2.20	0.029	*
AISI Type 446	0.12	0.73	0.024	0.011	0.36	0.26	24.0	*	0.17	*

*Present only as a residual amount, element not intentionally added.

Table 2. Creep-Rupture-Test Results for the Steels Investigated

Steel	Test Temp. F	Stress, psi For Rupture in			For Creep Rate of 0.01 Percent per hour
		100 hr	1000 hr	10,000 hr*	
Type 302	1600	4700	2800	1750	2500
	1800	2450	1550	960	1300
	2000	1300	760	460	620
Type 309S	1600	5800	2500	†	3500
	1800	2600	1650	1000	1000
	2000	1400	830	480	760
Type 310S	1600	6600	4000	2500	4000
	1800	3200	2100	1350	1750
	2000	1500	1100	760	800
Type 310 Cb	1600	5000	2500	1300	2400
	1800	2200	1200	660	460
	2000	1050	700	460	170
Type 314	1600	4700	3000	1950	2300
	1800	2600	1600	960	1000
	2000	1500	1120	850	900
Type 316	1600	5000	2700	1400	2600
	1800	2650	1250	600	1200
	2000	1120	360	†	400
Type 446	1600	1100	720	†	800
	1800	700	500	†	420

*Extrapolated data. †Rupture times not long enough for extrapolation.

Table 3. Rating of Steels Investigated Based on Their Extrapolated 10,000-Hour Creep-Rupture Strength

	Steel	Strength Rating*	Rank at Indicated Test Temperature†
1600°F	310S	100	1
	314	78	2
	302	70	2
	309S	56	3
	316	56	3
	310 Cb	52	3
	446	19	4
1800°F	310S	100	1
	309S	74	2
	314	71	2
	302	71	2
	316	49	3
	310 Cb	49	3
	446	26	4
2000°F	314	100	1
	310S	89	2
	309S	57	3
	302	54	3
	310 Cb	54	3
	316	15	4

*Expressed as percent of the maximum creep-rupture strength of the strongest steel at the indicated temperature.

†Arranged in order of decreasing strength; that is, the rank of 1 is the highest, and a rank of 4 is the lowest.

NOTE: The small differences between certain values, such as 78 and 70, or 52 and 56, especially with extrapolated numbers, had led us to rate these groups in the same rank and that they can be considered equivalent.

Table 4. Hardness-Test Results for the Steels Investigated Before and After Long-Time Creep-Rupture Testing

	Type of Steel						
	302	390S	310S	310 Cb	314	316	446
Annealed Condition Prior to Testing							
Diamond pyramid hardness	189	169	153	164	166	150	173
Rockwell B hardness*	91	86	81	85	86	80	87
Exposed at 1600°F for Indicated Time							
Exposure time, hours	844	439	607	1428	1037	668	582
Diamond pyramid hardness	208	134	156	161	176	132	180
Rockwell B hardness*	94.5	74	82	84	88	73	89
Exposed at 1800°F for Indicated Time							
Exposure time, hours	685	1677	1217	2652	1304	925	2081
Diamond pyramid hardness	409	198	193	181	134	220	174
Rockwell B hardness*	41.5†	92.5	91.5	89	74	96.5	87.5
Exposed at 2000°F for Indicated Time							
Exposure time, hours	1018	1174	1701	1119	1868	192	
Diamond pyramid hardness	201	234	225	164	172	182	
Rockwell B hardness*	93	99	97.5	85	87	89.5	

*The Rockwell hardness values were converted from diamond-pyramid-hardness values.
†Rockwell C hardness.

Creep: At normal, ambient temperatures, a structure designed on yield strength deforms to some extent immediately upon load application and then no further deformation occurs with time. But at elevated temperatures this same structure will continue to deform with time. This continued deformation under load is called "creep." Creep eventually can result in "creep-rupture" when the ultimate strength of the material is reached.

Designing for creep

Creep rate depends on the applied stress, temperature, and the composition of the metal.

Creep tests establish finite values for the creep rates. This is fortunate from a design point of view for without such data, structures might be highly over-designed. With creep data in hand, the designer can select design stresses which recognize the occurrence of creep, at the same time limiting it to tolerable values within the contemplated life span of the system.

Fracture due to creep raises another limitation. Here, the designer must consider time when selecting design stresses. The "time until fracture" variable for a given metal may be determined by creep-rupture tests.

Creep and creep-rupture tests are identical except that in the latter case stresses are higher and the test is carried to failure. Essentially, test specimens are held constantly at the temperature of interest, under static load, and elongation is measured periodically. Customary testing time is from 1000 to 3000 hours, although it can range from several hours to over 10 years. The measured creep strength is commonly expressed as (a) the stress producing a creep rate of 0.0001% per hour, or (b) the stress for a creep rate of 0.00001% per hour at the given temperature. Rupture values are usually reported as the stress for fracture in 100, 1000, 10,000, or 100,000 hours at the specific temperature.

Design for elevated temperature structures, therefore, must base design stresses on long-time creep and rupture strength, and take into account the limiting temperature determined by the scaling resistance of the material.

When you're faced with the subtle problems of designing for maximum performance at red heat, we invite you to talk to our technical representatives. We have some of the best high-temperature specialists in the business. They're men who can help you with your problems. As a start, write for a copy of our data-packed book, "Steels for Elevated Temperature Service." United States Steel, Room 6663, 525 William Penn Place, Pittsburgh 30, Pa. And for assurance of quality when you specify high-temperature steels, specify USS.

USS TRADEMARK **United States Steel**

Math Model Trouble-Shoots Minuteman

Autonetics' cost-cutting approach reported at Military Electronics Conference; SNAP-8 test plans outlined

LOS ANGELES—A new, mathematical approach to trouble-shooting promises to cut the cost of *Minuteman* guidance and may replace all electronic trouble-shooting procedures at the Autonetics Division of North American Aviation.

The technique, involving a computerized mathematical model dubbed SYCATE (SYmptom CAuse TEst), was described by Autonetics' H. T. Breen and H. W. Webb at the National Winter Military Electronics Conference held here recently.

In the *Minuteman* program, circuit reliability is assured by a rule that a component thought to be responsible for failure of a circuit cannot be used in any other *Minuteman* circuit even if it passes all performance tests after being removed from the board. If many components must be replaced before the real cause of failure is determined, repair of the board becomes very expensive. SYCATE is intended to reveal the cause with a minimum of part removals.

The SYCATE mathematical model predicts the values that will be measured at circuit test points if one or more parts or input sources have failed. Computer predictions are arranged in tables, and comparison with actual test point values indicates the most probable cause of failure. A number of circuit analysis procedures used in Autonetics design work are based on the same mathematical model required for SYCATE. Therefore, the two procedures can be developed simultaneously, providing both the information needed to improve the design and that needed to trouble-shoot the circuit after it is in production.

A SYCATE analysis requires that upper and lower limiting test values be determined from circuit requirements. Actual test point readings are printed out along with the evaluation "high," "low," or "good."

SYCATE is believed to be general enough to deal with most failure modes of any electronic circuit. Computer simulation of these failures makes it possible to list test values for each failure and invent a simple, accurate procedure for locating the cause of failure. The SYCATE program is still being refined and is not yet in use on the production line.

• **SNAP test plans**—The test program for the SNAP-8 nuclear-electric turbogenerator for space-power systems was outlined for the conference by Dr. Fred Schulman of NASA.

First flight test is to be in 1967, and the test vehicle will probably be launched by a *Saturn* series booster. Of the 3000-lb. weight of SNAP-8, about half will be reactor shielding and about a third will be the radiator to dissipate waste heat. Reactor, power conversion components and structure make up only one-sixth of the 35-kilowatt system's weight.

Later this year, SNAP-8 components will be launched from Wallops Island, Va., to test them in a Zero-g environment. The payload will be a SNAP-8 condenser tube and fin configuration in which the boiling and condensation of mercury will be observed during the weightless coast phase at the apex of a ballistic trajectory, pressure and temperature measurements will be collected and visual observations will be made. The launch vehicle will be a two-stage solid-propellant rocket. The flight test will be conducted by NASA's Lewis Research Center.

Component and subsystem development will continue through 1964. Concurrent 10,000-hour and 2000-hour tests of non-nuclear subsystems will run through 1966. Tests of the complete nuclear-electric system are to begin in 1965 and will culminate in a 10,000-hour (15-month) endurance run. Lewis's space propulsion facility will conduct the nuclear ground tests.

• **Man in Moon landing**—Computer simulation of soft lunar landings in which the pilots manually modify an automatic perturbed gravity-turn descent indicate that the system is "marginally acceptable," W. J. Knowles and D. J. Rose of Hughes Aircraft Co. reported.

During the complete series of simulated lunar landings, 74% were successful, 19% were crashes, and 7% were aborts. Experienced operators were able to make acceptable landings quite consistently except when extreme overshoots in the automatically controlled trajectory were programmed into the simulation problem. Operator loads were found to build up severely near touchdown.

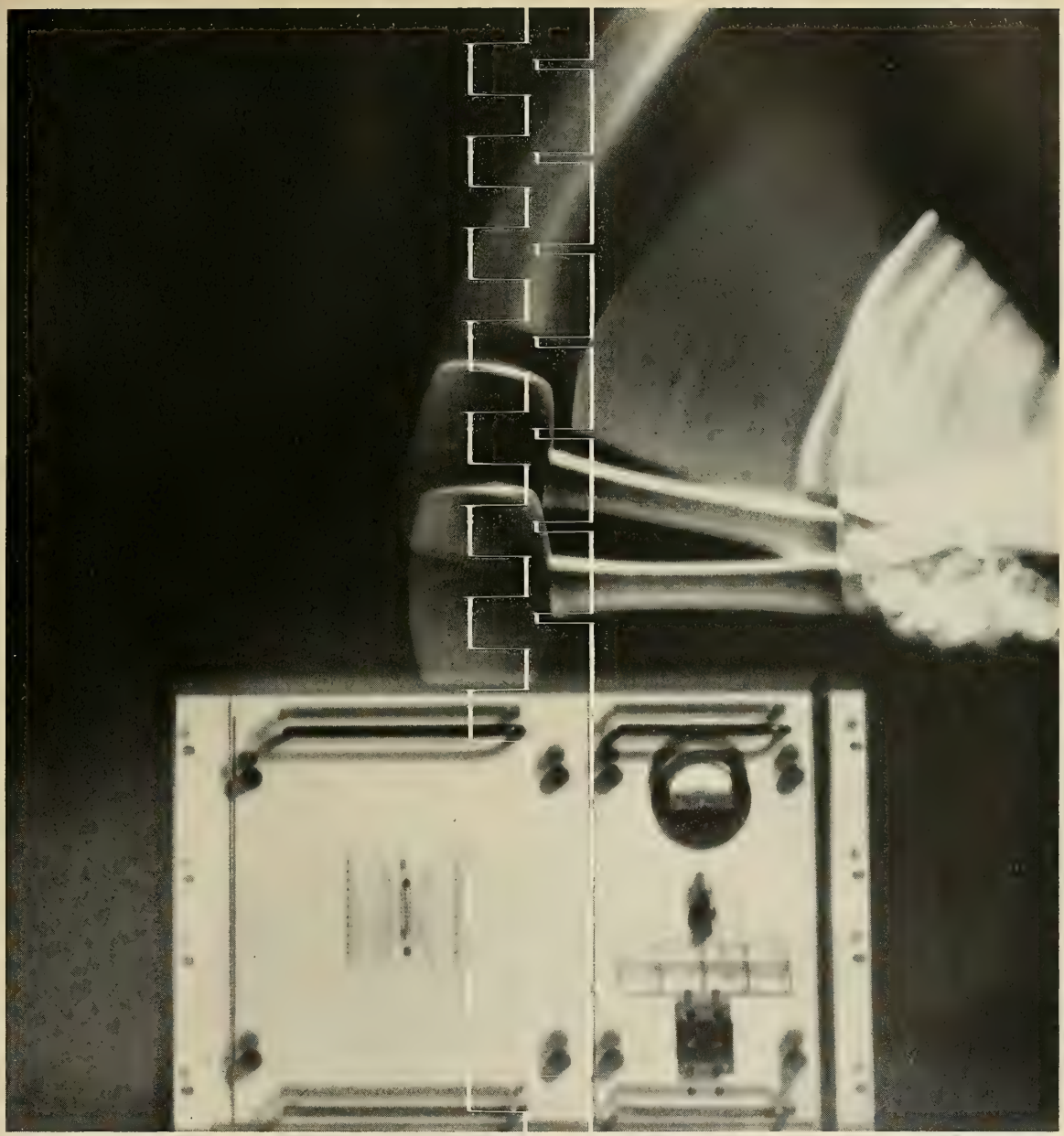
The information displayed to the two-man crew was similar to that required by the automatic system programming the gravity-turn maneuver. Pitch and yaw information was presented by a four-element cross-pointer and position along the flight path was presented on an oscilloscope and a large X-Y plotter. Control responsibility was divided with one simulator pilot handling pitch and yaw maneuvers and the other controlling thrust. The controls were simple one-axis levers.

• **Pattern plotting** — A method of using sferic signals generated by lightning to plot very-low-frequency receiver antenna patterns was described in a display prepared by the Naval Ordnance Laboratory, Corona, Calif.

Conventional methods of determining antenna patterns are ruled out by the vast (8 mi. by 15 mi.) size of the Lab's VLF antenna and by its large aperture. The antenna cannot be rotated past a fixed antenna, and airborne transmitters would have to circle the antenna at a distance of more than 200 mi. The Navy has six high-powered VLF transmitters at various places in the world, but they are too few to permit plotting of the gain pattern of the big fixed antenna.

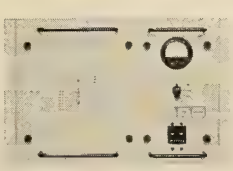
Because of the unsuitability of any man-made transmitter, NOL turned to sferics—bursts of electromagnetic energy released by lightning discharges at frequencies between 10 kc and 30 kc in the VLF band and with radiated power of about three billion watts. They can be detected far from the discharge because VLF signals are attenuated by only about 2 db per 1000 km. NOL receives as many as 10,000 sferics per minute, with ample variety in direction of arrival.

In the passive pattern plotter designed by NOL, the strength of the signal received by the big directional antenna is compared with that received by an omnidirectional 20-ft. dipole which provides the baseline for determination of antenna gain. A crossed loop antenna direction finder supplies the direction of arrival. A polar plot of the data shows the antenna gain pattern. The feasibility test model of the plotter has a bearing resolution of 3 degrees. ⁂



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Asteroids Stir Growing Interest

Scientists plan probes of close-approach objects that may answer mystery of how universe began

by Dandridge M. Cole
General Electric
Missile and Space Division

RECENT re-discovery of the close-approach asteroid, Ivar, has highlighted increasing scientific interest in the Minor Planets—which may retain the best existing record of the early history of our solar system.

Dr. Harold C. Urey says the answer to some of the major problems of cosmology—the nature of the universe—may be found on the asteroids.

Although the major emphasis in the current space program is concentrated on manned lunar flights, Earth-orbiting satellites, and Mars and Venus probes, many scientists are drawing up plans for investigating the asteroids.

One such scientist, Ray L. Newburn, Jr., of Jet Propulsion Laboratory, has outlined many possible important scientific experiments that could be performed by probes similar to *Ranger* and *Surveyor* sent to the asteroids. These experiments probably would be about as difficult, and as costly, as the *Mariner* and *Voyager* interplanetary probes.

• **Ancient questions**—Mars, Venus and the other planets in our solar system are like Earth in that they have atmospheres; they may in the distant past have had oceans. Hence their surfaces have been transformed by eons of weathering forces.

Even the Moon probably has suffered from a type of weathering, caused by extremes of temperatures and solar radiation, and may be covered by dust or other weathered material.

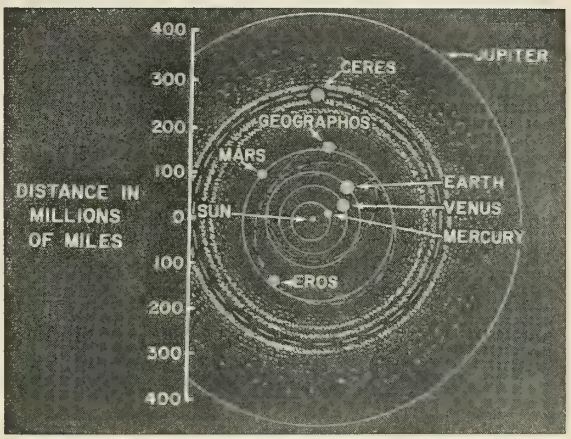


CHART shows orbits of some representative asteroids.

The asteroids may hold the best record of the early history of the system. Even if this is not the case, they certainly have the best record of their own origin. And since this was apparently a unique event in our system, it is of interest for its own contribution to cosmology and cosmogony (the origin

(Continued on page 46)

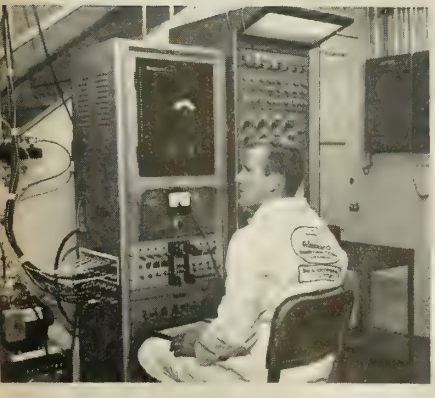
No.	Name	t_o	M_o deg	ω deg	Ω deg	i deg	e	n sec	a A.U.	R_p A.U.	R_A A.U.	Close Approach to Earth A.U.	Diameter mi	P yr
433	Eros	1931 Jan. 18	0.586	177.930	304.071	10.831	0.2398	2015.293	1.4581	1.1084	1.8078	0.15 (1975)	15	1.761
719	Albert	1911 Oct. 2	7.929	151.940	186.094	10.825	0.5406	853.665	2.5852	1.1876	3.9828		2-3	4.157
887	Alinda	1942 Jan. 31	358.049	348.119	111.029	9.024	0.5398	886.351	2.5212	1.1602	3.8822			4.003
1221	Amor	1948 June 3	22.165	25.549	171.202	11.924	0.4346	1334.746	1.9190	1.0850	2.7530	0.115 (1956)		2.658
1566	Icarus	1950 Aug. 7	53.499	30.912	87.746	22.979	0.8266	3171.432	1.0777	0.1869	1.9685	0.042 (1968)	I	1.119
1580	Betulia	1952 Dec. 14	291.862	158.888	61.874	52.037	0.4928	1090.753	2.1954	1.1135	3.2773	0.156 (1963)	I	3.253
1620	Geographos	1954 Dec. 24	195.077	276.211	336.999	13.325	0.3352	2556.94	1.2441	0.8271	1.6611	0.073 (1969)	I	1.388
1627	Ivar	1957 July 1	353.558	166.963	132.851	8.430	0.3965	1394.004	1.8642	1.125	2.603	0.48 (1962)	3	2.545

Explanation of symbols: t_o = Epoch, M_o = Mean anomaly at epoch t_o, ω = Longitude of the perihelion, Ω = Longitude of the ascending node, i = inclination of orbital plane to ecliptic, e = Eccentricity, n = Mean daily motion, a = Major semi-axis, R_p, R_A = Perihelion and aphelion distance, P = period of revolution.

TABLE GIVES most of the available data on some representative members of the close-approach group of asteroids.



The oil drum that breathes



Monitoring panel for Space Environmental Chamber at AiResearch incorporates IR 15-A Infrared Analyzer. Also shown, a Beckman F-3 Oxygen Analyzer, Type R Dynograph® Recorder.

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It's called a Metabolic Simulator. Built by Garrett-AiResearch for development of the environmental control system for Project Apollo, this oil drum-plus-hardware reacts to its environment just like one, two or three astronauts on a round trip to the Moon. It breathes in and out, grows hot and cold, damp and dry. Analyzing data from these tests is step number one in getting man ready for way-out space.

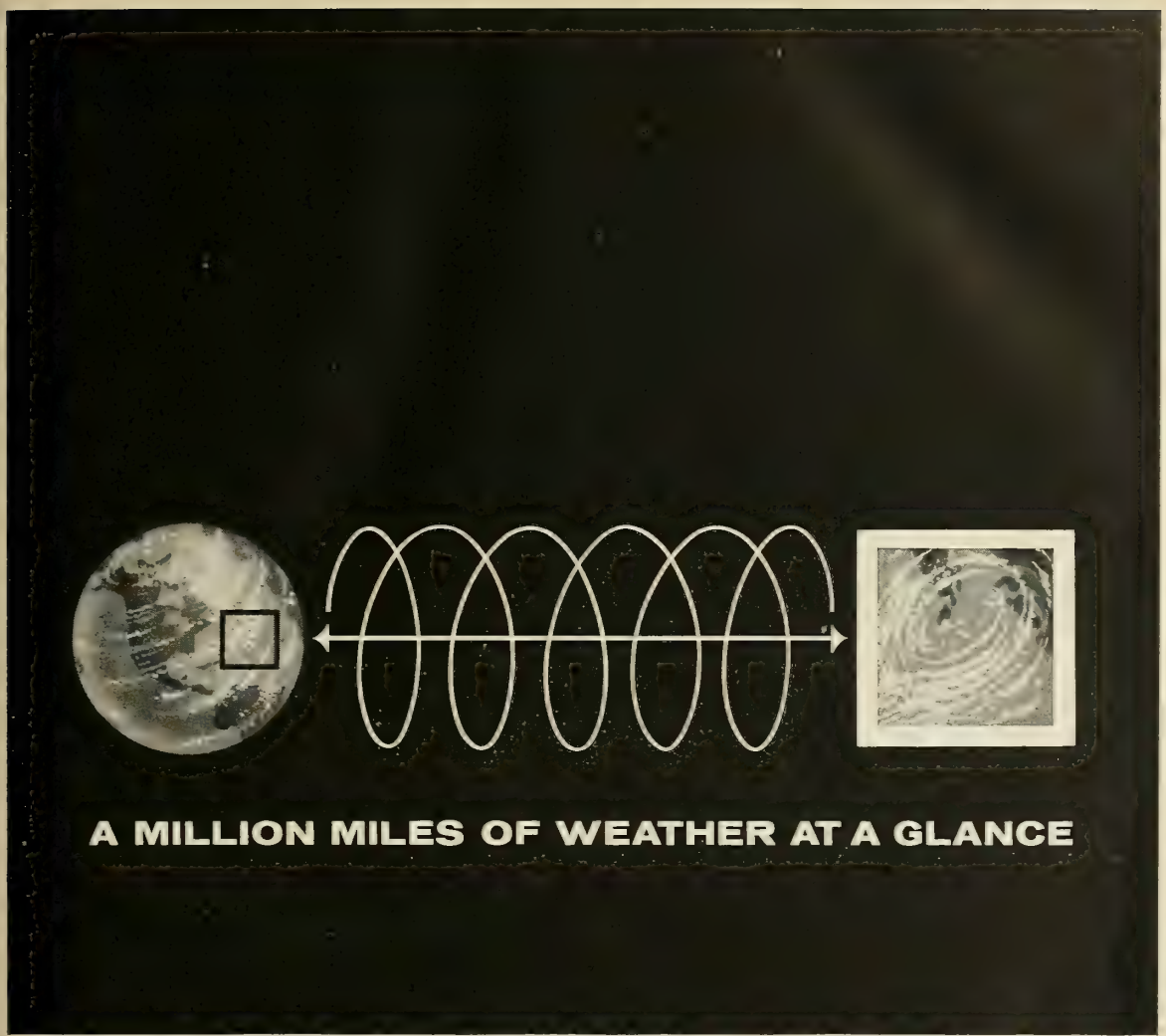
To measure the CO_2, AiResearch required a process infrared analyzer which offers unmatched sensitivity and stability over long periods. The Beckman IR 15-A delivers just what they're looking for. Three deciding factors: sensitivity to 0.1 ppm with ranges from ppm to 100%, accuracy of ±1% full scale, and zero drift of ±1% full scale for eight hours. The IR 15-A, first of the non-dispersive analyzers, is still first choice!

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A significant experiment is rapidly drawing to a climax. Soon a weather satellite will go into polar orbit carrying an Automatic Picture Transmission System (APT). As the satellite orbits the Earth it will continually photograph the cloud cover below and transmit pictures to a number of new low-cost ground stations scattered around the world. Through these stations for the first time, local weathermen will see millions of square miles of the Earth's weather at a glance. Remote ocean, desert and mountain areas, oftentimes the breeding ground for the most devastating storms, will be subjected to regular surveillance. This new approach to weather analysis will probably undergo preliminary tests using the Tiros satellite in the middle of the year. Toward the end of the year, the Nimbus satellite for which the system was designed, will be launched. Fairchild Stratos-Electronic Systems Division has developed and is producing APT ground stations under the technical direction of NASA's Goddard Space Flight Center. For more information, on this system, contact our Director of Customer Relations.

When there's a need to know: Fairchild Stratos-Electronic Systems Division capabilities are best reflected in an integrated approach to data requirements. Extensive experience in acquisition, processing, transmission and display has given FS-ESD engineers a particularly sensitive awareness of both final information needs and the many subsystems required to answer them. • *For knowledgeable engineers interested in career opportunities in advanced data techniques, may we suggest a note to our Director of Industrial Relations for the brochure "Grow Your Own Future". FS-ESD, an equal opportunity employer.*

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The Asteroids

(Continued from page 43)

of the universe).

Modern techniques of dating by measuring concentrations of radioactive isotopes could be used to determine the ages of the asteroids, the time since they were last in the molten state, and other aspects of their history.

Optical and X-ray spectroscopy can be used to determine the chemical makeup of these objects, which will in turn provide clues to their origin. At present we have almost no firm data on the nature of most of the asteroids except their orbit characteristics. They are simply points of light of different intensities which follow predictable paths around the Sun. (An exception to this generalization is the telescopic observation of an elongated shape in the asteroid Eros, strongly implying a single solid chunk of matter rather than dust, liquid, or gas. Also, the observed fluctuations in brightness of some of the asteroids indicate tumbling of irregular solid objects.) If we *assume* values for density and composition, we can estimate mass, or vice versa.

The main group of asteroids has orbits with both perihelia and aphelia beyond the orbit of Mars, and most of them remain in orbit between Mars and Jupiter.

Of some 1600 known objects in this group only four—Ceres, Pallas, Juno, and Vesta—have measured diameters. These are, respectively, 475, 300, 125, and 250 miles. The four objects listed are presumably the largest of the asteroids and were the first discovered—in the order given.

While the main group of asteroids is of great interest and will be explored eventually as our probes begin to reach beyond Mars, the immediate interest is in the close-approach or cis-Martian group.

• **Close-approach group**—Asteroids of the close-approach group have until now been little more than curiosities. To some astronomers they have been largely a nuisance, and astronomers in general have devoted little effort toward gaining more information about these remarkable objects.

While some such bodies have come within one million miles of Earth during this century, and have actually struck Earth and the Moon in large numbers in past ages, we will arbitrarily include all objects which come closer to the Earth than Venus—26 million miles—in the close-approach group.

Actually, almost no firm data are available for any of these small asteroids except their orbit characteristics. Most of what is known of representative members of the close-approach

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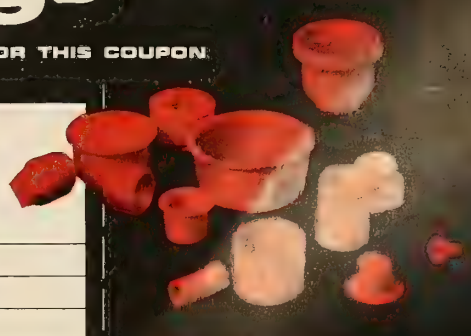
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group is summarized in the table on p. 43. Some illustrative orbits are shown in the chart on p. 43.

The firm data comprise orbit paramcters known with varying accuracy for points of light of varying intensities. Diameters have been estimated on the basis of brightness and assumed albedos. However, since the compositions are not known, the albedo estimates could be grossly inaccurate.

Masses can be estimated from the assigned volumes if densities are assumed. But again some basic assumption must be made regarding composition, and there is no direct evidence to support any particular theory of the chemical structure of these objects.

It has generally been believed that asteroids are similar in composition to the iron or the stony meteorites—or perhaps that both types are represented in the asteroid belt.

Opik, however, has argued that they may represent the heads of comets. Thus the densities of the asteroids might range anywhere between that of iron and something considerably below that of water (cometary material).

It might be thought that a close approach between two asteroids could provide information on their masses through observation of the resulting perturbations. No such phenomenon has ever been observed, however, and Rabe has calculated that none is likely in the near future.

Several sightings of an asteroid are required before it is given official status by assigning it a permanent number designation in the "Ephemerides of the Minor Planets," published by the Institute of Theoretical Astronomy in Moscow. Currently, 1650 asteroids have been identified for inclusion in the ephemeris. It has been estimated that tens of thousands of asteroids exist in the regular belt brighter than the nineteenth magnitude.

• **Male and female**—With the discovery of Eros (433) on Aug. 13, 1898, the first of the "male" asteroids was recorded. (Generally, masculine names are given to asteroids with very exceptional orbits, femine names being the rule for asteroids in the regular belt.) In the 64 years that have elapsed since this first discovery of a "close-approach" asteroid, only eight minor planets with highly elliptical paths which come close to the Earth's orbit have been observed sufficiently well to receive a permanent number.

A total of 12 close-approach asteroids have been sighted during this time, as indicated in the table. Of this number

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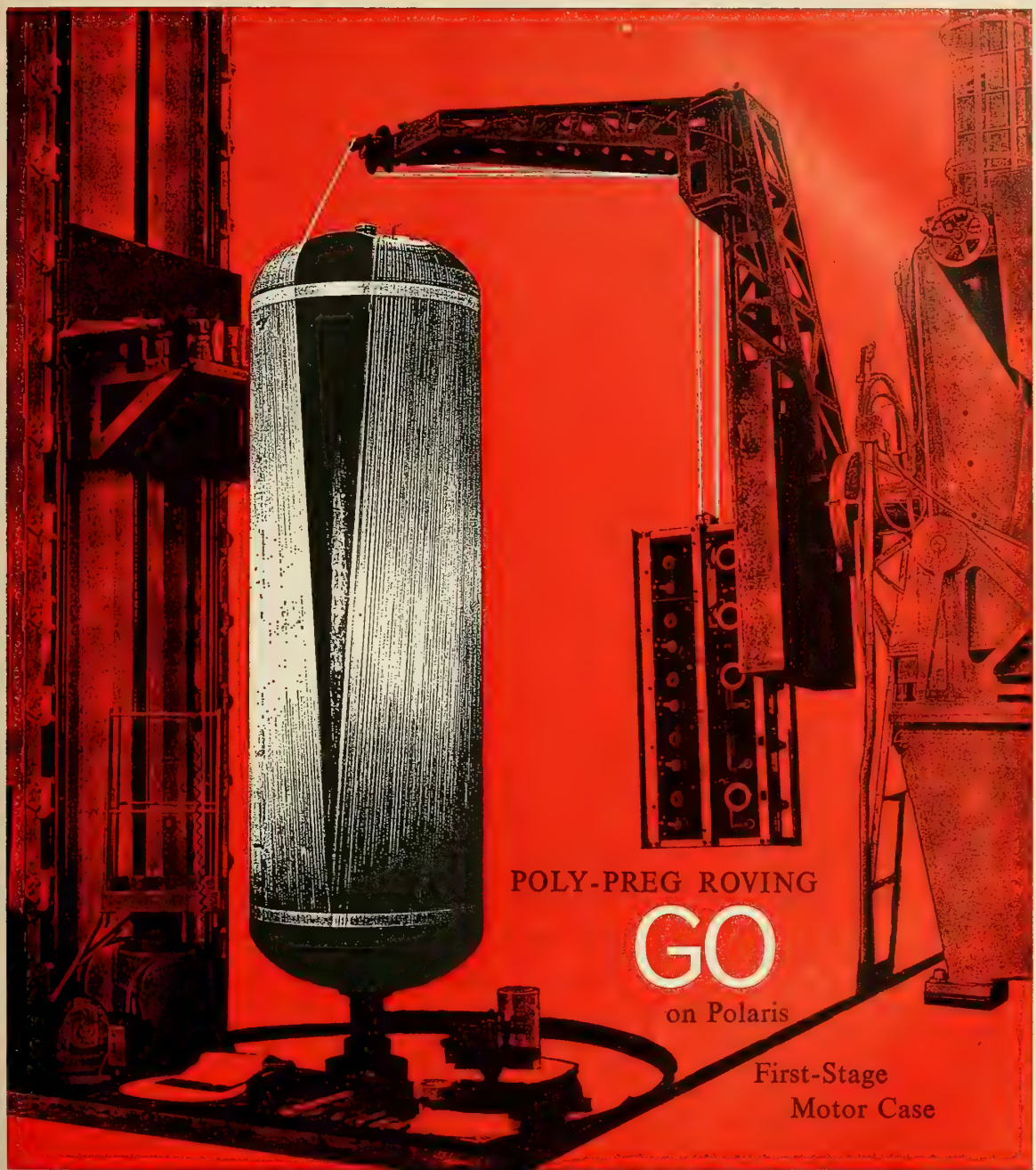
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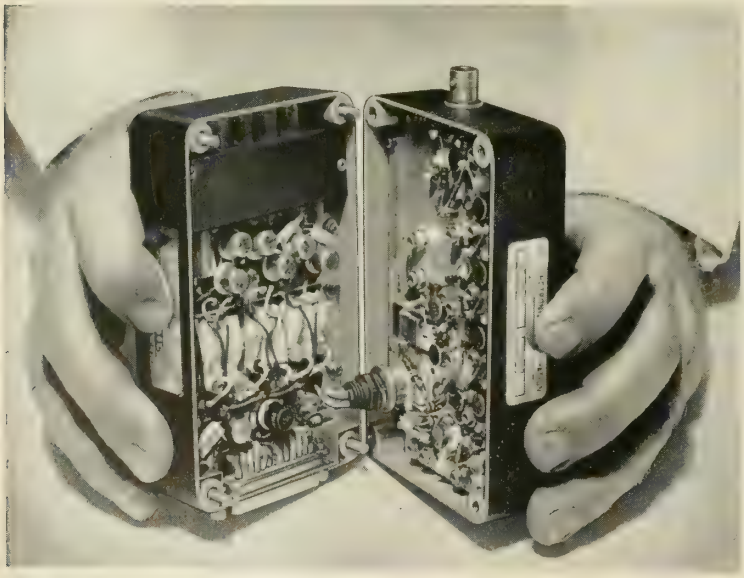
Not that we know of — RS Electronics command equipment has been successfully flown in thousands of flights, in both missiles and drones. These flights demonstrate that, with high reliability RSE equipment, you command with confidence.

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RSE design gives you maximum flexibility with standard receivers mating with standard 2, 3, 5, 6 and 10 channel decoders. All equipment is pretested, qualified, and ready to plug in and use.

Whatever your command application may be, up to the highest military standards, we welcome the opportunity to examine your requirements. If we don't have a standard unit suited for your purposes, we'll gladly produce one.

SPECIFICATIONS (Typical Receiver/Decoder) **Frequency** 406-549 Mc / **Sensitivity** Five microvolts / **RFI** Meets MIL-I-26600 / **Environment** MIL-E-5422 E Class 1 / **Size and Weight** 43 cu. in., 35 oz. / **Outputs** Six independent commands.



PERFECT MATES: RSE command receivers and decoders are designed to mate with each other, regardless of the number of channels, to provide maximum utility. In all cases the result is a small, lightweight package capable of meeting military airborne environments.

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3

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only five have been observed with sufficient accuracy to establish satisfactory predictable orbits. The most recent of these, No. 1627, Ivar, has been placed in this category as a result of observations that began in March of 1962 and continue at the present time.

• **False alarms**—Asteroids are susceptible to confusion with man-made vehicles because of their motion with respect to the star background, and the close-approach asteroids are more critical in this regard because they more nearly approximate the motion of man-made satellites or missiles. The consequences of such confusion might be quite serious unless information regarding the ephemerides of these natural objects is made available to all nations as soon as possible.

All close-approach asteroids have been found by accident; no organized program has existed to search for them. The advent of man-made satellites and spacecraft creates an urgent need for such a search.

Asteroids have added to the development of the science of celestial mechanics by the solution of problems associated with their motion and by improvements in the astronomical unit through careful observations of the close-approach asteroid, Eros.

From a scientific point of view, the asteroids also are a key factor in determining the mean density of matter in the solar system. This datum is extremely important in establishing a distribution of solar system mass, which is vital to an understanding of the evolution of the universe. The number, size, density, composition, and distribution of the minor planets are important missing links in this chain of knowledge.

Astronomers have estimated that there may be thousands of these objects up to a mile in diameter on close-approach orbits. Much smaller objects down to perhaps 100 ft. in diameter, with a mass of approximately a billion pounds, could number in the hundreds of thousands.

Such objects would be negligibly small by astronomical standards and have thus been of little interest to astronomers. However, by astronautical standards (payloads carried to escape velocity) they are enormously large and should be of great interest to space explorers. Many possible uses of these objects should be considered. Many of these would depend on unlikely combinations of orbit parameters, but the estimated very large number of such objects suggests it is reasonable to expect to locate one or more with useful characteristics.

• **The twins**—The most interesting of close-approach asteroids is one which has not yet been discovered—although

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aerospace and defense products

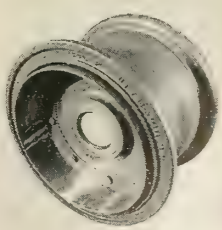


14-pound magnesium wheels carry heavyweight missile

The Army's Pershing missile system is planned for maximum mobility. Thus, the missile's Erector-Launcher unit, equipped with BFG wheels, is designed to be air transportable.

With both high strength and low weight important, BFG cast magnesium wheels were selected. The wheel weighs only 14 pounds (compared to a steel stamping originally considered of 39 pounds). Each wheel weighs but half as much as its tire! Yet each wheel is rated for 6000 pounds, and in tests withstands 26,600 pounds ultimate on the axle.

To save weight on air transportable vehicles, draw on the long experience of BFG in producing aircraft wheels in light metals. This can solve your strength/weight problem. For information contact *B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Dept. MR-2, Troy, Ohio.*



Wheels for air transportable Erector-Launcher, built by Unidynamics, a division of Universal Match Corporation.

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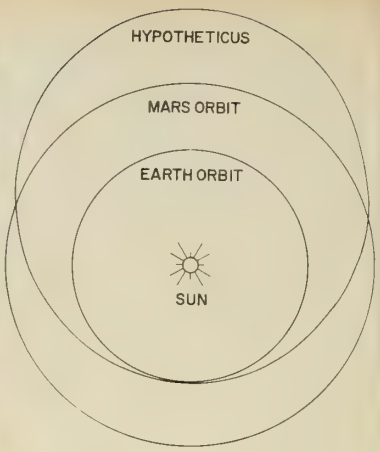


TRANSPONDERS

PROVEN RELIABILITY IN ACTUAL USE makes Motorola radar transponders the logical choice for critical tracking, data and control missions. Case in point... AN/DPN-66 (Motorola SST-102A) illustrated above, **USED ON SATURN, PERSHING** and over 15 other current aerospace programs. A precision C-band unit, weighs 10.8 lbs., occupies 40 cu. in., it is just one of a complete line of transponders available for fast, off-the-shelf delivery. Others include: **USED ON SCOUT, PROJECT FIRE** and **BSMR**  SST-131, this transponder is an extremely rugged microminiature superheterodyne unit, weighs only 3 lbs. and occupies just 40 cu. in., qualified for high-thrust, solid propellant boosters. Power: 400 watts. Sensitivity: —65 dbm. **USED AT AFMTC**  AN/DPN-71, a high-power, superheterodyne unit for deep-space tracking assignments. Power: 20 kw. Sensitivity: —75 dbm. **USED ON SATURN,** and **PERSHING**  AN/DRN-11, UDOP (UHF Doppler) transponder provides extreme range and position accuracy for ballistic vehicles. Power: 3 watts (15-watt power amplifier optional). Sensitivity: 5 microvolts. **USED ON NAVY AIRCRAFT**  AN/APN-132, an X-band transponder with 5 channel decoder. Power: 100 watts. Sensitivity: —65 dbm. For full performance specifications, or modification data to meet other parameters, write our Instrumentation Products Group.

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ASSUMED ORBIT of "Hypotheticus" close-approach asteroid—actually two bodies named Major and Minor, respectively.

its discovery in this decade is not unlikely. We call this somewhat idealized member of the family "Hypotheticus".

Actually Hypotheticus is twins, with the distinguishing names Major and Minor. Major is three miles in diameter and composed primarily of iron while Minor is only 100 ft. in diameter and composed of rock, ice, organic compounds, long-dead micro-organisms, etc.

What is the chance that Hypotheticus Major or Minor will be discovered in the near future?

Kuiper is now engaged in a study of photographic plates taken along a 20° segment of the ecliptic in a deliberate search for asteroids. It has been estimated that some 2000 new asteroids will be found. Of these perhaps only three will be of the close-approach group.

If this search were continued to include the whole ecliptic, then perhaps 50 to 60 new close-approach objects would be discovered. And if the searching technique were changed to favor the discovery of close, high-speed, objects rather than distant ones, then hundreds, or even thousands could be discovered. Out of hundreds or thousands we could be sure that some would approach quite closely to the idealized orbit parameters of Hypotheticus. Hypotheticus is probably there. We just haven't seen him yet.

• **Applications**—Considerable scientific interest is developing in the prospects for increasing our knowledge of the asteroids. Newburn has described a number of scientific experiments which should be performed to provide us with some firm data regarding the nature of these objects. Urey has supported the need for new methods of investigation other than classical telescopic search.

Kohler has discussed possible search

techniques which could be applied to the discovery of large numbers of close-approach objects. In particular, the image enhancement equipment used by at least two observatories in photographing Ivar would be useful.

Kuiper's current search, if extended to include the whole ecliptic, could provide sufficient basis for reasonable extrapolations of size and distance distributions. Herget's computation of the orbits of the new objects should provide a better basis for the next phase of investigation involving rocket probes.

There are no more intriguing questions in science than those of the origin of the solar system and the origin of life. Important clues to the solution of both of these mysteries might be found on the asteroids.

Because of the erosive effects of atmospheres and oceans, the planets may be no more helpful in this respect than Earth itself. While more interesting to the cosmologist than the planets, even the Moon may have suffered from erosion in its early history and thus may not provide as accurate, or ancient, a record as the asteroids.

The recent discovery of what may have been alien life forms on meteorites has increased biological interest in the asteroids. If these are actually alien life forms, where did they originate?

Urey points out that the asteroids are an exceedingly unlikely place for life to evolve and suggests that these meteorites may be fragments knocked off the Moon. Although the Moon may also appear inhospitable to life, evolution of simple forms during the Moon's early history seems more plausible than evolution on the asteroids.

Answers to questions regarding the age, chemical composition, and biological condition of the asteroids could be answered by soft landings of *Surveyor*-type payloads. While more difficult than the simple fly-by experiments, soft landings on the close-approach asteroids should present only the same order of difficulty as soft lunar landings, and should be feasible with near-future vehicles.

Operational uses of the close-approach asteroids have been suggested previously by several authors. Levitt, Ehricke and the present writer have considered the possibility of "hitchhiking" on an asteroid as a method of interplanetary travel.

• **Some pessimism**—It is suggested that the mass of the asteroid would provide excellent radiation shielding for the crew of an interplanetary vehicle, although obviously no gain would be made in propulsion energy through this technique.

In fact, Ehricke becomes pessimistic regarding the desirability of such an operation, because *greater* propulsion



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energy would be required than for a similar trip in the rocket vehicle itself. Icarus and Geographos (the two bodies considered) are inclined to the ecliptic plane 23° and 13° respectively, and thus orbit matching would be an expensive undertaking.

Ehricke does not consider three interesting possibilities which make the future use of the asteroids for manned bases more attractive.

First, there is the possibility, or in fact high probability, that objects with more suitable orbits will be discovered. This probability is increased by the fact that objects of astronomically infinitesimal size, formerly undetectable, would be suitable for this purpose. (Hypotheticus Minor.)

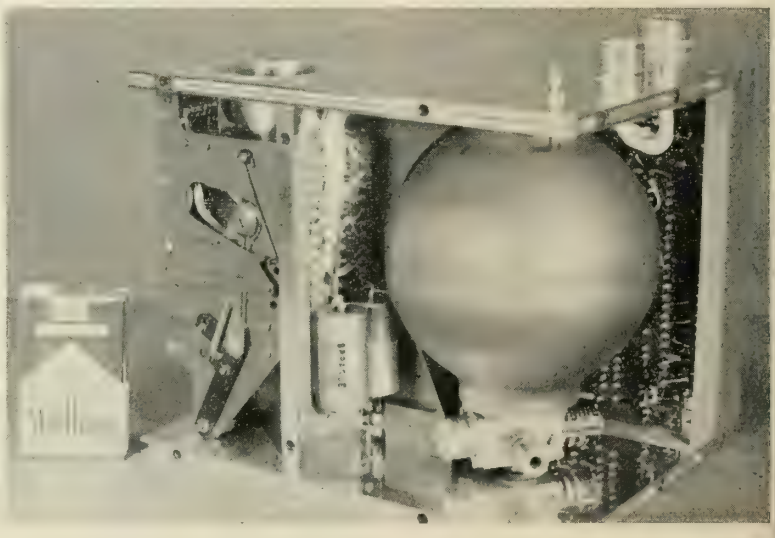
Second, there is the possibility that the materials of the asteroid could be used not only for shielding but after processing, for supplies and propellants.

The asteroid materials might serve as reaction mass for a nuclear pulse rocket, a nuclear thermal rocket or an ion rocket. Some meteorites have been found to contain up to 10% water as water of crystallization. This could be split by nuclear or solar energy to use as a chemical propellant. A supply of hydrogen and oxygen moving at interplanetary velocities would be an extremely valuable resource.

Finally, there is the value of a scientific base on an asteroid for its own sake rather than as a stepping stone to the planets. Many possibilities would be open to the scientist which would not be possible on the Moon, Mars, Venus, or a close-Earth-orbit laboratory.

In 1958 the writer and D. E. Muir considered the possibility of capturing the asteroid Hermes and using it for an Earth satellite. While it was found that the energy required to bring Hermes to Earth was relatively small, establishing it in an Earth orbit was quite another matter. The relative or "impact" velocity of Hermes was estimated to be about 11 m.p.s. Reducing this to less than 7 m.p.s. by atmospheric breaking did not appear feasible.

However, it should be noted that Hypotheticus would impact at only 7.6 m.p.s. or 40,000 f.p.s. If an atmosphere grazing contact were arranged, rather than direct impact, it might be possible to reduce the velocity below 7 m.p.s. and cause an Earth capture. Of course, perigee for the new orbit would then be in the atmosphere, and it would be necessary to provide Hypotheticus with a slight kick in the apogee to raise his perigee and provide him with a permanent Earth orbit. ⁂



Beckman's Compact Lunar Gas Chromatograph

THIS 12-LB. instrument has been delivered by Beckman Instruments, Inc. to Jet Propulsion Laboratory for use in NASA's Surveyor Moon probe program. It is designed to analyze 28 constituents believed to be present on the Moon's surface and sub-surface—including water, nitrogen, carbon monoxide, carbon dioxide, and a number of additional organic compounds. The manufacturer says it is the first chromatograph instrument capable of analyzing solid samples. Walt Donner, manager of Beckman's Space Engineering Group, Scientific and Process Instruments Division, Fullerton, Calif., said the device has been engineered to withstand the shock and vibration involved in spacecraft launchings, as well as the difficult space environment of vacuum and extreme temperatures. He reported that it has been subjected to vibration amplitudes approaching 300 g's and survival temperatures below —185°C. The Beckman unit was developed under a $680,000 JPL contract.

HERE IS A PARTIAL LISTING OF CONTENTS

UNITED STATES GOVERNMENT:
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

INDUSTRIAL SECTION:
Detailed listings of major missiles/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

COMPANY REPRESENTATIVES SECTION:
Listing company representatives stationed in Washington and in most strategic missile/space areas.

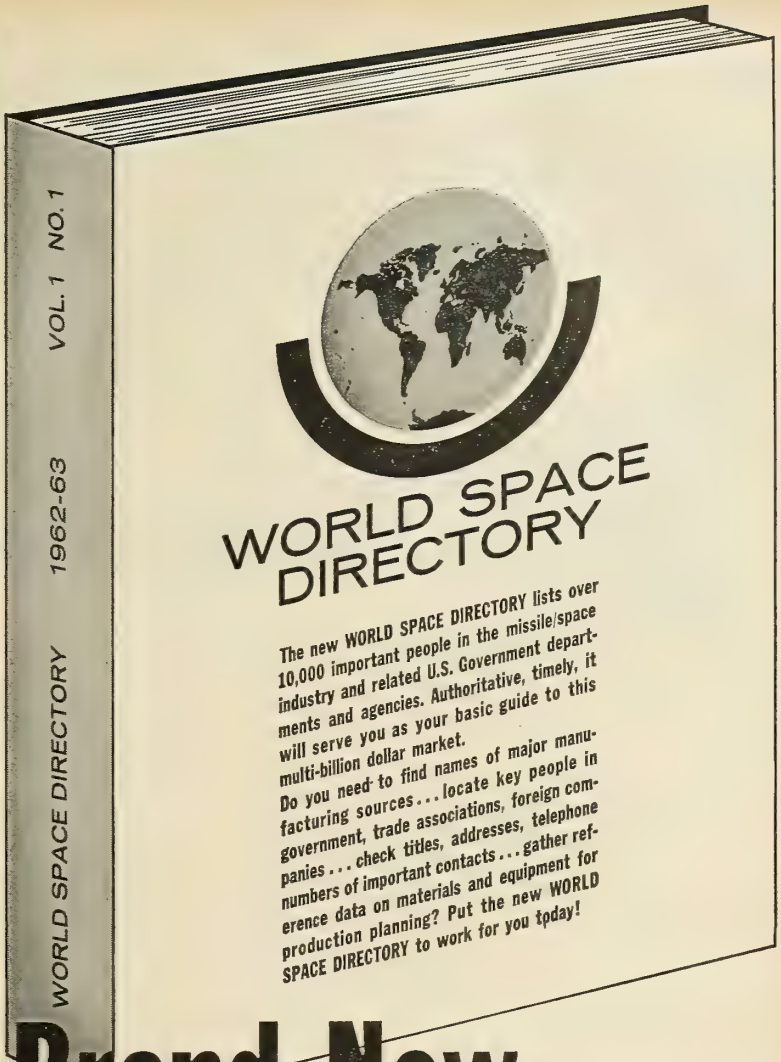
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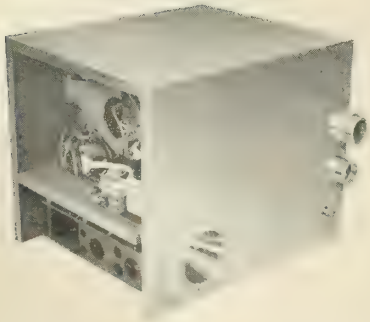
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Navy League Exhibits Canceled

Recognizing a significant, continuous industry trend away from exhibiting at meetings, the Navy League has decided to have no industrial exhibits at its 1963 convention.

Neither will there be any major large-scale receptions by individual companies during the sessions, to be held April 29 through May 24 in San Juan, Puerto Rico.

The most recent Aerospace Industries Assn. survey of industry participation plans for 1963 exhibits and shows indicates a continued vote strongly against such activities. The poll, taken in January, shows the Navy League to be very hard hit by the downward trend, with planned participation reported by only three firms, and 31 companies surveyed indicating a firm decision against showing at the meeting.

"With the uncertainty of industrial exhibits being continued," the Navy League said, "it was felt that a new approach should be tried this year."

The League has decided to try a new system, by which 20 firms would be invited to participate as convention sponsors, each paying a contribution of up to $2500. In appreciation for the support, sponsors would be recognized in all printed matter of the convention, special badges would be made up for all attending representatives of the sponsor firms and the senior official of each sponsor firm would receive a special certificate of appreciation. Sponsor firms would also have first choice of reserved suites at the headquarters hotel and special accommodation considerations at other hotels.

Other, similar incentives are being considered by the League to encourage contributors to support its convention.

In return for such Navy League benefits, sponsors would be restrained from holding receptions or other functions for large numbers of people: "All entertainment will be provided by the Navy League." Also, hours of all hospitality suite operations would be governed by the League.

The AIA survey that may have influenced the Navy League's change of plans queried 47 aerospace firms. Here are some of the results shown of display plans for various 1963 meetings: Air Force Assn.—no 27, yes 7, undecided 9; Assn. of U.S. Army—no 24, yes 12, undecided 7; American Rocket Society—no 26, yes 8, undecided 11; Society of Automotive Engineers—no 36, yes 3, undecided 4; American Society of Mechanical Engineers—no 36, yes 3, undecided 4; Institute of Radio Engineers—no 29, yes 10, undecided 5; Armed Forces Communications and Electronics Assn.—no 36, yes 4, undecided 4.

California Shares the Wealth

Though California is truly the Golden State in terms of defense procurement funding, the amount of spill-over to other states is considerable, a Los Angeles Chamber of Commerce survey reports.

Though one independent authority privately criticized the poll as being lacking in scope and depth because of poor response from the firms surveyed, he said the study is valuable at least as a rough guide on California industry's spread of military procurement funds to other parts of the country.

During Fiscal 1962, six of the largest military prime contractors in California reportedly spent more than $1.6 billion in all other states and the District of Columbia. This figure is estimated to represent more than half the California defense procurement dollar.

The New England states and the Great Lakes Region got the lion's share of the funds, 26.7% and 11.5%, respectively. New York alone received more than $128 million, nearly eight percent of the defense business subcontracted by California firms.

Approximate figures for other states include: Connecticut, $107.4 million (6.67%); New Jersey, $89.3 million (5.55%); Ohio, $84.5 million (5.25%); Massachusetts, $55.9 million (3.47%).

Freon Cleaning Saves Titan Funds

Martin Co. expects to cut more than $16,000 from *Titan II* program costs by using a new method of cleaning the safety suits used in working with toxic fuels, a spokesman says.

A freon shower technique has been substituted for the laborious hand-scrubbing methods formerly used to remove toxic vapors and meet sanitary standards.

The principal saving, Martin says, will be in manpower costs. The freon bath requires only five minutes, while scrubbing with detergent took 90 minutes. This means a cut in costs from $6.35 to $1.10 per suit.

ITT Seeks ComSat Stock

International Telephone and Telegraph Corp. has applied to the Federal Communications Commission for authority to buy stock in the newly formed Communications Satellite Corp.

An ITT spokesman said the firm is believed to be the first major carrier to submit an application.

The only stock purchase authorization announced to date by the FCC will allow each of the OSC's 12 incorporators to buy a single share of no-par capital stock at $100 per share. Commission spokesmen said the authorization was made at the request of the ComSat Corp. itself.

ITT developed and built the ground communications system for the *Courier* satellite; and the firm previously received a license—the first of its kind—to bounce signals off the moon to explore the communications possibilities of such techniques. And the firm is also working on various projects related to *Telstar* and *Relay*.

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North American Aviation

contracts and procurements

AIR FORCE

$5,409,566—**Anaconda Wire and Cable Co.,** Hastings-on-Hudson, N.Y., for inter-site cables for *Minuteman* missile sites. Work to be done at Cambridge, Mass.

$4,600,000—**General Dynamics Corp.,** San Diego, Calif., for additional *Atlas* missile research and development work.

$3,205,500—**Douglas Aircraft Co.,** Santa Monica, Calif., for space programs launch support work for Air Force, NASA and DOD projects. Work to be done at Vandenberg AFB, Calif.

$2,489,900—**Radio Corp. of America,** Camden, N.J., for work on the *X-20 (Dyna-Soar)* communications and tracking subsystem.

$2,000,000—**Telemetrics, Inc.,** Gardena, Calif., for provision of 17 universal telemetry decommutation systems for use on the Atlantic Missile Range.

$1,930,000—**System Development Corp.,** Santa Monica, Calif., for continued work on systems training programs.

$1,400,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for space program work.

$1,089,754—**General Electric Co.,** Philadelphia, for test equipment work.

$1,032,480—**Fairchild Camera and Instrument Corp.'s Fairchild Defense Products Div.,** Syosset, N.Y., for design and development of photographic image interpretation equipment.

$1,000,000—**General Dynamics Corp.,** San Diego, Calif., for research and development, test and fabrication of *Atlas* missiles (supplemental contract).

$306,400—**Avco Corp.'s Research and Advanced Development Div.,** Wilmington, Mass., for radiation research experiments.

ARMY

$2,100,000—**Hughes Aircraft Co.,** Culver City, Calif., for development studies leading to design of a new wire-controlled antitank missile called *TOW*.

$150,000—**Rocket Power, Inc.,** Mesa, Ariz., for production of *Judi-Dart* meteorological sounding rockets.

NAVY

$12,681,686—**General Electric Co.,** Schenectady, N.Y., for nuclear reactor components.

$8,541,000—**George A. Fuller Co. and the Vinnell Corp.,** Los Angeles, Calif., for construction of a *Polaris* missile facility at the Navy Ammunition Depot, Bangor, Wash.

$4,987,000—**General Electric Co.,** Pittsfield, Mass., for guidance missile systems for *Polaris* submarines.

$4,449,217—**Sperry Rand Corp.'s Sperry Gyroscope Div.,** Great Neck, N.Y., for converting modification kits for radar missiles.

$3,400,000—**Bendix Corp.,** Mishawaka, Ind., for continued research and development of the *Typhon* missile system.

$3,274,263—**Vitro Corp. of America's Vitro Laboratories Div.,** Silver Spring, Md., for additional *Terrier* missile systems engineering services.

$1,600,000—**General Precision's Information Systems Group,** Glendale, Calif., for additional fire-control systems for submarines.

$1,001,750—**Sperry Rand Corp.'s Ford Instrument Div.,** New York, for fire-control engineering services.

NASA

$15,029,420—**Raytheon Co.,** Lexington, Mass., for *Apollo* lunar mission work. Work to be done at the Houston Manned Spacecraft Center.

$5,500,000—**Catalytic Construction Co.,** Philadelphia for construction of synchrocyclotron to be used for advanced relation studies in support of space missions and associated equipment. Work to be done at Newport News, Va.

$4-5,000,000—**Marion Power Shovel Co.,** Marion, Ohio, for design and development of a giant transporter vehicle for use at Cape Canaveral.

$2,000,000—**Radio Corp. of America's Astro-Electronics Div.,** Hightstown, N.J., for additional *Tiros* weather satellites.

$478,000—**Telecomputing Services, Inc.,** Los Angeles, for the operation of a central computer facility at Slidell, La.

$434,000—**General Precision's Kearfott Div.,** Little Falls, N.J., for floated rate-integrating gyros for use on *Mariner* spacecraft.

$99,988—**Martin Construction,** Merritt Island, Fla., for a launch operations support at Complex 37.

$68,858—**Molecular Research, Inc.'s Electronic Systems Div.,** West Palm Beach, Fla., for design criteria for a closed-circuit television and operations, intercommunication system for NASA's Launch Operation Center, Cape Canaveral.

$62,000—**Sylvania Electric Products, Inc.'s Applied Research Laboratory,** Waltham, Mass., for research concerning new ways for unmanned space vehicles to "see" objects in color.

$48,000—**System Development Corp.,** Falls Church, Va., for analysis of planning and status of *Orbiting Astronomical Observatory (OAO)* ground data system.

$41,835—**Midwest Research Institute,** Kansas City, for unsolicited program of temperature prediction and analysis.

$22,600—**Naval Air Material Center, Air Crew Equipment Laboratory,** for support of *Gemini* ejection seat program.

AEC

$700,000—**General Atomic Div. of General Dynamics Corp.,** San Diego, Calif., for a preliminary design study and for performance of exploratory development on the 1000 mw (e) system.

INDUSTRY

$2,250,000 — **Fairchild Camera and Instrument Corp.,** Syosset, N.Y., from **McDonnell Aircraft Corp.,** for production of advanced panoramic camera systems.

$650,000—**Moog Servocontrols, Inc.,** East Aurora, N.Y., from **General Dynamics/Pomona,** for electrohydraulic servo-value components in the flight-control system of advanced *Terrier* and *Tartar* missiles.

$622,000—**Consolidated Electrodynamics Corp.** Monrovia, Calif., from **Hercules Powder Co.** for pressure transducers for the *Minuteman* missile.

$529,000—**Systron-Donner Corp.'s Donner Div.** Concord, Calif., from **Lockheed Missiles and Space Co.,** for additional ignition programmers for the *Polaris* missile.

$450,000—**Alco Products, Inc.,** Chicago, Ill., from **FMC Corp.'s Ordnance Div.,** for the manufacture of heavy-duty springs and spring assemblies to be installed in *Minuteman* missile sites.

Moog Servocontrols, Inc., East Aurora, N.Y., from **General Dynamics/Pomona**, for flight-control hardware for the *Mauler* missile (undisclosed amount).

Curtiss-Wright Corp., Wood-Ridge, N.J., from **United Aircraft Corp.**, for high-precision segmented-steel rocket cases for solid booster stage of *Titan III-C* (undisclosed amount).

Ralph M. Parsons Co., Los Angeles, from **North American Aviation's Space and Information Systems Div.**, for an *Apollo* engine test facility at White Sands, N.M. (undisclosed amount).

Textron's Bell Aerosystems Co., Buffalo, N.Y., from **North American Aviation's Space and Information Systems Div.**, for provision of the positive expulsion tanks for the reaction control system of the *Apollo* spacecraft (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston, Tex.

An environmental control and life-support system for a manned earth-orbiting space station shall be parametrically studied. Optimization shall result in recommendations for environmental control subsystems; a preliminary integrated design of these subsystems; and the requirements of weights, volumes, and power for each. RFP MSC 63-389P. RFP due date 3-13-63.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Lathe and accessories. Delivery to George C. Marshall Space Flight Center, NASA, Huntsville, Ala., M/F Bldg. 4471. Lot IFB MSFC 63-184. Bid opening 3-4-63.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Requires a service to provide personnel, equipment, facilities and materials for a study of launcher-umbilical connections at pad. Bidders should demonstrate in their proposals previous experience in work of a similar nature. JOB RFP Q-36-3. RFP due date 3-8-63. Contract Eugene Sweat.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Program of research development and testing to demonstrate a capability for producing filament-wound fiberglass vessels suitable for storage of cryogenic propellants and, at the same time, obtain other useful data. The program will include design and development of small-scale fiberglass filament-wound pressure vessels, fabrication of these vessels, testing at liquid-hydrogen temperature, and testing at liquid-nitrogen temperature. To be considered responsive to this RFP, an offerer must demonstrate experience in filament winding of fiberglass pressure vessels and testing as indicated above. Job—RFP APO-2014. RFP due date 3-11-63.

Special Contracts Branch
Special Procurement Div.
U.S. Army Missile Command
Redstone Arsenal, Ala.

Selected source procurement with North American Aviation, Inc., Downey, Calif., for four months contract for HIDE applications for Army missiles in connection with the Army Missile Penetration Aids Program. This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.

BIG ADVANCES

in Technology Today Are Reserved for Those Who Understand the

INTERDEPENDENCE OF ALL DISCIPLINES

Essential to Nuclear Submarines

The nuclear powered submarine is one of the most complex weapons systems yet devised. To the exacting requirements of building a ship to operate safely, quietly and efficiently at high speeds in the rigorous environment of *inner space*—as foreign to man as interplanetary regions and in many aspects still as unexplored—are added the problems of nuclear propulsion plant engineering, missile systems operation, and life support conditions for *scores* of men.

It is no wonder, then, that Engineers from many disciplines work together—and in so doing, broaden their professional scope—at Electric Boat, birthplace of the nuclear powered submarine.

Positions Are Open Now for
AE's, EE's, ME's, ChE's, CE's
Metallurgical & Welding Engineers
for Assignments in

STRESS ANALYSIS
STRUCTURAL DYNAMICS
STRUCTURAL ENGINEERING & DESIGN
WELDING METALLURGY
TEST ENGINEERING & DESIGN
PIPING & FLUID SYSTEMS DESIGN
SOUND, SHOCK & VIBRATION ANALYSIS
STATISTICAL SIGNAL ANALYSIS
QUALITY/RELIABILITY CONTROL & ASSURANCE
LIFE SUPPORT SYSTEMS ENGINEERING
OPERATIONS RESEARCH & DESIGN OF EXPERIMENT
ELECTRONICS ENGINEERING

- Design of special instrumentation for measurement of acoustic & vibration data
- Design and installation of interior communication systems, navigation systems, ship control systems, depth control systems, steering & diving devices
- Application & systems engineering of radio, radar, sonar and countermeasures systems & components
- Missile fire control and instrumentation systems
- Integration of control and instrumentation systems

Your inquiries are invited.
Please address Mr. James P. O'Brien.

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ENGINEERS / SCIENTISTS / PHYSICISTS / MATHEMATICIANS

MEN



ON THE WAY

UP

Men at Honeywell *are* on their way up! How do you measure *your* success? Is it through the attainment of broader responsibilities, or through a constantly rising level of experience and competence within your specialized field of interest? Capability, in either direction, is rewarded at Honeywell in Florida and professional assignments leading to your career growth are open at all levels.

Among our immediate needs are . . . **Systems Engineers / Circuit Designers / Logic Designers / Systems Analysts / Programmers / Packaging Engineers / Rotary Component Designers / Systems Test Engineers / Materials & Component Engineers / Test Equipment Designers / Manufacturing Prototype Development Engineers / Reliability Engineers / Quality Control System Engineers.**

This long list reflects our continuing expansion in every phase of precision guidance systems and techniques. We are currently working on such vital projects as Gemini, Dyna-Soar, Centaur and others. Interested? We'll promptly reply to your confidential inquiry. Send resume to M. N. Keese.

And remember, your family will enjoy Florida's Suncoast living.



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To investigate professional openings in other Honeywell facilities, send your resume to **H. F. Eckstrom, Honeywell, Minneapolis 8, Minnesota.**

HONEYWELL ENGINEERS ARE DOING THINGS IN FLORIDA

General Support Div.
Directorate of Procurement & Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

The U. S. Army Missile Command proposes to procure from the Northrop Corp., Ventura Div., repair parts in support of the *RP-76* target missile system. Firms interested in subcontracting opportunities must direct inquiries to Northrop Corp., Ventura Div., Van Nuys, Calif.

National Aeronautics and Space Administration
General Research Procurement Office
Houston 1, Tex.

Feasibility and design study of low-level radiation altimeter system. Delivery to NASA, Manned Spacecraft Center, Houston 1, Tex. RFP MSC-63-448P. RFP due date 3-13-63.

Integrated carbon dioxide reduction system development. Delivery to NASA, Manned Spacecraft Center, Houston 1, Tex. RFP MSC-63-447P. RFP due date 3-13-63.

It is contemplated that performance specs for the furnishing of a main drive d-c vertical 6700-HP motor capable of developing a peak torque of 3,200,000 lb-ft to 11 RPM and intermittently at speeds between 11 and 42 RPM, and associated motor generator control equipment and computer direction response capability will be available on or about 4-1-63. Interested prospective contractors should request general specs, which will be available starting 2-25-63. Requests will not be accepted later than 3-8-63 by Procurement & Contracts Div., Manned Spacecraft Center, NASA, Houston 1, Tex. Attn: APCC. Period of performance will be 16 months after receipt of notice to proceed by successful bidder.

Subcontracting Opportunties
Aerospace Procurement Div.
Subsystems Procurement Branch
Norton Air Force Base, Calif.

Guided missile components in support of the SM65 *(Atlas)* missile guidance subsystem. (1) 14308259864AC oscillator, precision frequency 4560 CPS-48 each, (2) 14308259865AC oscillator, precision frequency 4560.75 CPS-46 each, (3) 14308-263230AC oscillator, precision frequency 4090 CPS-35 each. Delivery instruction to be furnished at a later date. RFP 04-607-63-462. Items being procured were previously developed and obtained from American Bosch Arma Corp., Arma Div., Garden City, N. Y., Hill Electronics, Inc., 300 N. Chestnut St., Mechanicsburg, Pa., and Bulova Watch Co., Inc., Electronics Div., 6110 Woodside Ave., Woodside 77, N. Y. Drawings, engineering data, specs and copies of RFP not available through Air Force channels for distribution. Negotiations are being conducted with the above companies. Inquiries relating to subcontracting opportunities should be directed to the above firms.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Universal testing machine. Deliver to George C. Marshall Space Flight Center, NASA, Huntsville, Ala. Item—IFB 63-189. Bid opening 3-4-63.

Tape, delivery to George C. Marshall Space Flight Center, Item—IFB MSFC 63-211. Bid opening 3-5-63.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Environmental chambers—4 each. IFB S-2063. Bid opening 2-28-63. Bid sets available through Miss R. Russell, Bid Officer, 4811 Lawrence St., Hyattsville, Md.

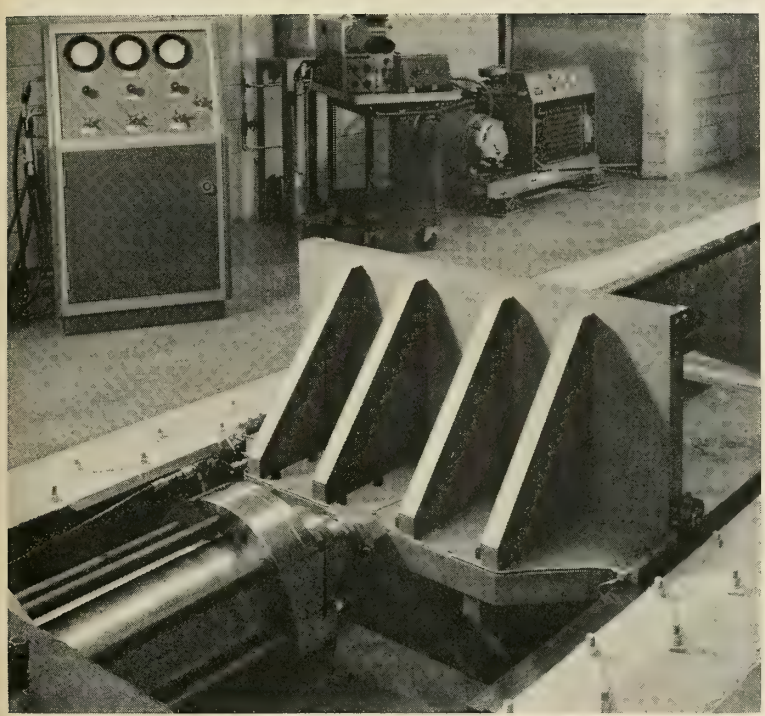
Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Dolly, handling, for rocket motors, steerable, pneumatic tires—9 each. IFB L-3073. Bid opening 3-8-63. Copies of IFB and RFP will be furnished to the extent available on a first-received, first-served basis.

Lewis Research Center
21,000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with the Oak Ridge Technical Enterprises Corp., 140 E. Division Rd., P. O. Box 485, Oak Ridge, Tenn., for neutron detection system—1 each. RFP C-78141. Note: For information purposes only. No RFP available.

Circle No. 29 on Subscriber Service Card



New Product of the Week:

Shock Tester

A shock tester, the HYGE HY-12000, is available from Consolidated Vacuum Corp. with a nominal thrust rating of 250,000 lbs. force at 3000 psig load pressure. It can produce all types of shock waveforms that have quarter-cosine energy envelope decay, and produces half-sine and quarter-cosine waveforms with three to 875 g accelerations, depending on the weight of specimen and carriage. Many of the waveforms possible with HYGE cannot be duplicated by any other means.

HYGE can be used as a velocity generator for producing controlled, repeatable velocities on large and small specimen packages. This velocity-generating capability can also be used in conjunction with an impact medium to produce shock waveforms with repeatability, and eliminates the need to develop new impact media by "cut and try" methods when changing waveforms.

Circle No. 225 on Subscriber Service Card

Magnetic Tape Search Unit

Hyperion Industries, Inc. Digital Products Div. is marketing a universal magnetic tape search unit designated Model HI-205. The device is capable of controlling a reproduce magnetic tape transport for automatically locating portions of the tape on the basis of selectable time indices previously recorded during data acquisition. Time code input to the Model HI-205 may be any of the commonly known formats. Changing from one time code to another is accomplished by rear mounted code adapter plugs.

Uncontrolled search speed (backward and forward) may be used since the unit employs digital filtering for distinguishing the binary "ones," "zeros" and markers. An input automatic gain control circuit compensates for voltage amplitude changes of ±12 db over a frequency range of 5 cps to 100 kcps.

Circle No. 226 on Subscriber Service Card

10Kc Ratio Box

A precision inductive ratio divider designed for operation between 5 and 15 Kc with highest accuracy at 10Kc has been introduced by North Atlantic Industries, Inc.

The Model RB-510 features in-line switch readout of six decades, permitting ratio measurement from 0 to 1.111110. At 10Kc, the readout accuracy (terminal linearity) is 2.5 parts per million and the nominal input impedance at 10Kc is greater than 50,000 ohms. Phase shift is less than one minute of arc and output resistance is less than 0.6 ohms. Mil-T-27A transformers and six heavy duty rotary switches are used in a design that can meet military requirements. Resolution is one position in the sixth decade or one part per million.

Circle No. 227 on Subscriber Service Card

Fatigue Testing Machine

Micro Balancing, Inc. has developed a commercial high-speed rotation beam, random load fatigue testing machine. The Model M is available to meet the need for a fast, versatile machine that can economically test the large number of small size specimens subjected to load spectra of arbitrary shape and type. The unit determines fatigue life under constant load amplitude and/or programmed random loading.

It eliminates the effects of load history and resulting discrepancies in the observation of random fatigue life, and a great variety of materials under dynamic service conditions can be subjected to load programs previously not reproducible in a testing machine.

Circle No. 228 on Subscriber Service Card

Automatic Checkout System

Northrop Nortronics has developed a building block automatic checkout system which can meet any possible combination of test requirements by selecting off-the-shelf building-block modules and plugging them into the basic chassis.

A completely solid-state system, the SP-5 can be either tape-controlled or computer-controlled, depending on checkout requirements. Under tape control, the system uses a 500-ft. reel of Mylar tape that can be read at a speed of 250 frames a second, which exceeds the speed of any currently available equipment the SP-5 could be expected to test.

Circle No. 229 on Subscriber Service Card

Periodic Antenna

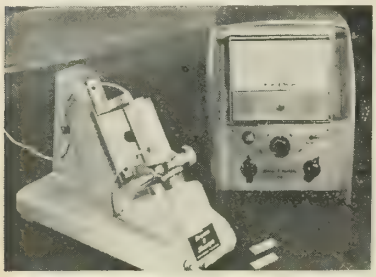
Andrew Corp. has developed a high gain, two-element log periodic array for operation in the 140-750 mc range. This broadband antenna, designed for monitoring and countermeasure applications, is ideally suited for telemetry and conventional communications systems.

Constructed of high-strength stainless steel tubing, the antenna is suitable for use in extreme environments. Mounting clamps for vertical or horizontal polarization are supplied.

Circle No. 230 on Subscriber Service Card

Electronic Gages

A line of transistorized electronic gages has been developed by Brown and Sharpe Industrial Products Div. incorporating stability in circuits to



make re-calibration unnecessary for up to 3000 hrs. In addition, amplification remains unchanged under temperature variations of 90 degrees between 32°F and 122°F, and line voltage variations between 90 and 125v a-c.

This high degree of stability is inherent in all three transistorized amplifiers, Model 961 low magnification, Model 962 high magnification and Model 964 differential.

Circle No. 231 on Subscriber Service Card

Glass Inlet System

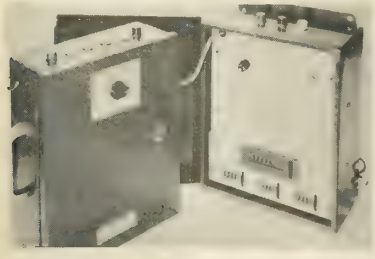
A heated glass inlet system which will permit liquids and solids to be introduced into mass spectrometers at temperatures up to 350°C has been developed by Consolidated Electrodynamics Corp. a subsidiary of Bell & Howell.

Designed for use with CEC's Type 21-103C mass spectrometer, the 21-084 inlet system allows introduction of liquids and solids that cannot normally be analyzed because of their insufficient vapor pressure.

Circle No. 232 on Subscriber Service Card

Utilization Monitor

Instruments named utilization monitors which record the performance of any machine, work party, production



line, or individual operator have been developed by the Datametric Div., Hancock Telecontrol Corp. The devices count any combination of productive time, setup time, idle time, downtime arising from two to five different causes, and pieces.

Circle No. 233 on Subscriber Service Card

IF Phase Meter

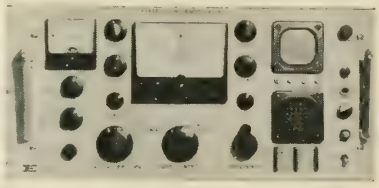
An all electronic IF phase meter, 2 mc to 100 mc, has been developed by Wiltron Co. The IF phase meter provides automatic measurement of relative phase from 0° to 180° with any 20° expandable to full scale. It is a valuable tool in checking overall microwave system performance since a measurement at IF frequency is also indicative of RF phase characteristics. The instrument could be used for working on phased-array radar systems, pulse compression radar, communications systems, and MTI radar.

The frequency coverage is set by a series of five local oscillator bands covering the bandwidth range of 2 mc to 100 mc. This local oscillator is tuned to the vicinity of the test signal where it is locked on by AFC. The actual phase measurement is then made at the difference frequency of 1½ mc.

Circle No. 234 on Subscriber Service Card

Phase-Lock Demodulator

The Electrac Model 215 phase-lock demodulator is available from Electrac, Inc. to demodulate AM and ϕM telemetry signals. The equipment operates from the IF of instrumentation receivers. Doppler shift on the carrier can be tracked with bandwidths of 3 to 300 cps over a ±50 kc range, and the unit incorporates a third order loop filter,



uses coherent AGC, has automatic seep and memory features and handles information bandwidths up to 150 kc. Features include built-in monitor oscilloscope, and solid state plug-in circuitry.

Circle No. 235 on Subscriber Service Card

Vidicon Camera Tube

X-ray sensistive vidicon camera tubes that can see through steel and other metals to detect flaws have been developed by the Machlett Laboratories, Inc., an affiliate of Raytheon Co.

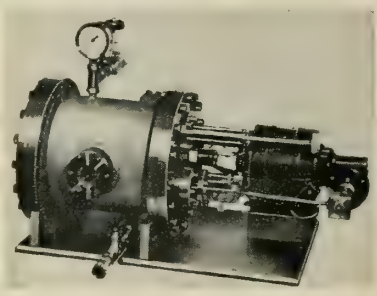
Particularly well adapted for testing electronic components such as transistors, diodes, tubes, resistors, condensers, printed circuits and various enclosed assemblies, the tube will also permit nondestructive testing of small castings and metal case weldments.

Detailed resolution exceeds 0.001-in. and image quality is comparable to fine grain, high-contrast radiographic film, making the ML-589 particularly well suited for applications requiring high resolution and magnification up to 50X.

Circle No. 236 on Subscriber Service Card

Insulation Tester

An insulation tester (Model 303) available from the Westinghouse Scientific Equipment Department, makes the testing of enamel-insulated wire used in electrical apparatus both fast and accurate. The tester determines how much



mechanical abuse the insulation will withstand within any atmosphere before contact between adjacent current-carrying conductors will be established.

Circle No. 237 on Subscriber Service Card

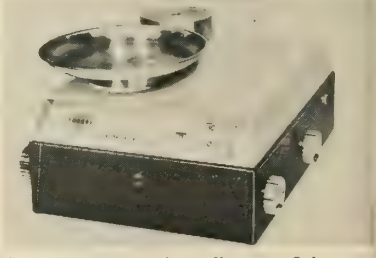
Solar Simulator

A mobile xenon solar radiation simulator is being marketed by Tenney Engineering, Inc. Both Earth-orbit and Venus-orbit intensities are available. A standard model, "Solar Sim," and custom-engineered units are available. All feature collimated beams of uniform intensity, continuous operation to 1000 hours, and close match of the Sun's spectrum. The light source is an unusual combination of both xenon and mercury xenon lamps, with infrared fill-in.

Circle No. 238 on Subscriber Service Card

Optical Balance

The Torsion Balance Co. is marketing Torbal PL-1 optical projection balance. The optical range of the balance



is 110 grams and readings to 0.1 gram are quickly, conveniently, and accurately made with the vernier. The Model PL-1 will perform efficiently even in corrosive or dust-laden atmosphere, and has no knife edges or bearings to become dull or worn—causing accuracy losses.

Circle No. 239 on Subscriber Service Card

(Continued on page 68)

Another SCHJELDAHL Materials Advancement

New Satelloon* materials by Schjeldahl make possible more efficient passive communications satellites...



12-Foot Prototype made with Schjeldahl materials demonstrate possible passive orientation technique.



Honeycomb Pattern of aluminum mesh is formed by chemically milling the metallic material surface; aluminum on one side or both sides, in register. Aluminum ribs rigidize the structure but allow most solar energy to pass through. **Surface can be up to above 90% open area.**



Cross Section of chemically milled material. Thickness may vary: Plastic from .0001-in. to .001-in.; metal from .0001-in. to .01-in.

PROBLEM: Develop a radio-reflective material suitable for use in passive communications satellites, capable of being packed for rocket launching, inflated and rigidized in space, and minimize the effect of solar pressure.

ANSWER: Chemically milled aluminum-plastic laminate manufactured by G. T. Schjeldahl Co.

After the successful ECHO projects, Schjeldahl people began working on two fundamental material improvements: one, the chemical milling of the metallic surface to produce an overall, even pattern – still effective in radio wave reflectivity, but relatively unaffected by solar pressure; two, rigidizing of the plastic-metal structure after inflation in space.

BOTH HAVE BEEN ACCOMPLISHED. Schjeldahl is now producing these materials in sufficient quantity to meet your needs. Write or call for specific information . . . Area code 507 – NI 5-5635.

OUR MAJOR NEED is for people experienced in plastic film, film handling equipment and special plastic-to-metal laminations. **An equal opportunity employer.**

Builders of ECHO I

Putting Materials Together Through Chemistry and Mechanical Design

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*G. T. Schjeldahl Co. T.M., Reg. U.S. Patent Office

Circle No. 19 on Subscriber Service Card

Start your advertising schedule in M/R's Military Systems Issue.

Military Systems Issue

● **M/R's March 25 issue** will report on the reorganization of the Department of Defense by Secretary Robert S. McNamara that has drastically shifted the military's procurement pattern. Buying decisions previously made at the level of the individual services now are increasingly being made in the offices of the Department of Defense itself. Who are these decision makers? How are DOD decisions made? How will the changes affect industry's traditional relationships with the Pentagon?

This issue will be the first in-depth analysis from an industry viewpoint of DOD's new procurement and engineering philosophy which has definitely modified the roles of the joint chiefs, the services and the service secretaries in major weapons systems policy, R&D and procurement decisions.

Three sections in the Military Systems Issue:

● **DOD Policies**—McNamara's Pentagon Reorganization / DOD Budget and Programs / Procurement / Research and Engineering.

● **DOD Operations**—How a Weapons System is Approved / How Industry Can Operate at the DOD Level / How Other Agencies Affect DOD Decisions / How Well is the Pentagon Reorganization Working?

● **The Decision Makers;** the role and influence of ten key DOD offices and agencies in missile/space decisions—Secretary McNamara's Office / Comptroller Office / Research and Engineering Office / Procurement Office / Joint Chiefs of Staff / Office of the Secretary of the Air Force / Office of the Secretary of the Army / Office of the Secretary of the Navy / Defense Supply Agency / Defense Communications Agency.

● **The Military Systems Issue** will be must reading for every one of over 41,000 paid M/R subscribers in industry and the military. Advertise in M/R's March 25 issue to gain maximum exposure for your products and capabilities.

● **Buy proven performance in Missiles and Rockets**—113 page advertising gain in 1962 / 36 page gain for January, 1963 over January, 1962 / 6700 new paid subscribers gained during 1962.

Issue Date: March 25, 1963

Closing Date: March 4
Plates by March 11

Start your advertising schedule in M/R's Military Systems Issue.

products and processes

(Continued from page 64)

Tube Sockets

A complete line of industrial, commercial and military tube sockets for either novar or magnoval tubes has been developed by Connector Corp. The line consists of types with metal saddles for either top or bottom mounting, printed circuit types and all-molded types. All are available in either general-purpose or low-loss phenolic or glass-filled alkyd insulating materials. Leakage paths have been increased for high-voltage versions.

Circle No. 240 on Subscriber Service Card

Magnetic Testers

Two models of precise magnetic testers specifically designed for evaluation of magnetic cores and circuits are being marketed from Electronic Memories, Inc. Design utilizes four basic, interchangeable modules: negative drivers, positive drivers, current calibrator and a program generator to achieve great flexibility of usage. A power supply module is used with all versions of the testers.

Where a variety of tests and program are to be performed, Model 150 is desirable, which includes the program generator module and allows toggle-switch control of program from the front of the unit. For more static requirements, Model 102, which has no program generator and requires manual repatching of banana plugs located at the back of the unit to accomplish program changes, is adequate.

Circle No. 241 on Subscriber Service Card

new literature

INSTRUMENT CATALOG—A short-form catalog of test instruments is available from Fairchild Semiconductor. The catalog describes a variety of test equipment for incoming inspection, engineering evaluation and manufacturing final tests. Tested devices include transistors, diodes, capacitors, inductors and resistors. Catalog data includes parameters tested, ranges and accuracy, along with photographs of the equipment.

Circle No. 200 on Subscriber Service Card

ENGINEERING WITH GLASS—32-page illustrated booklet, "Engineering With Glass" provides detailed information on the mechanical, optical, electrical, thermal and chemical properties of glass. Published by Corning Glass Works, the brochure also has sections on Pyroceram brand glass-ceramics, photosensitive glass, fused silica, and Cercor cellular ceramic structures. Other Corning materials described include multiform glass, Pyroceram brand cements, porous materials and "thirsty" glass.

Circle No. 201 on Subscriber Service Card

SPACE AGE FACILITIES—Denison Engineering has a 16-page, illustrated brochure reviewing the company's research and manufacturing capabilities in space-age applications. It analyzes the present and future role of hydraulic and electro-hydraulic power and control in such industries as missiles, ground support equipment, electronics, ship construction, transportation and machine tools. Illustrated examples of outstanding hydraulic applications in these fields are shown. The publication reviews Denison's physical facilities for space age hydraulic research, design and manufacturing, and sets forth the basic approach used by the company in solving power and control problems with hydraulic or electro-hydraulic systems.

Circle No. 202 on Subscriber Service Card

TUNNEL DIODE AMPLIFIER—Micro State Electronics Corp. has published a 10-page brochure, "Low Noise Tunnel Diode Amplifiers and Microwave Solid State Components," explaining the company's design approach and the manufacturing controls used to obtain very low noise characteristics and unconditionally stable microwave amplification. Complete technical specification and application information are listed for Micro State amplifier units. The brochure presents capsule information on switches, multipliers, harmonic generators, attenuators, and other microwave solid-state components.

Circle No. 203 on Subscriber Service Card

'DEUTSCH SORCERY'—An 80-page book describing Deutsch Co.'s facilities and capabilities for handling R&D and manufacturing contracts for fasteners, electrical connectors, hydraulic fittings and components, precision valving, and other precision metal parts.

Circle No. 204 on Subscriber Service Card

VOLTAGE-TUNABLE MAGNETRONS—A 28-page technical bulletin on voltage-tunable magnetrons is available from the Power Tube Dept., General Electric Co. Designated PT-68, illustrated brochure gives detailed information on VTM theory of operation and construction; as well as operating precautions and methods of application, including fixed-frequency and swept-frequency operation. Also discussed are suitability for use in severe environments and design of associated power supplies.

Circle No. 205 on Subscriber Service Card

AUTOCOLLIMATION
with
KERN DKM2 and DKM3
THEODOLITES

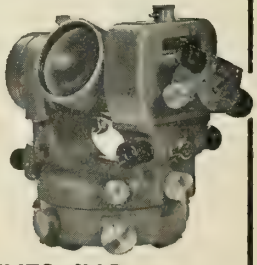


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your career potential with the **TITAN III** prime contractor and systems integrator. Martin Denver has challenging new career assignments at all science and engineering levels.

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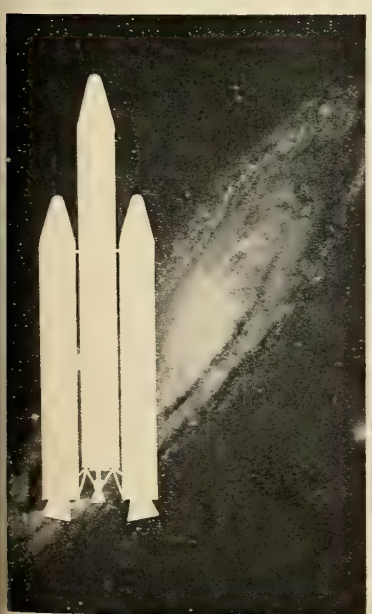
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- GUIDANCE and CONTROL
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Mail # A-64E

MARTIN MARIETTA

DENVER DIVISION
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–names in the news–

Lester K. Fero: Formerly with Martin Marietta Corp., appointed Chief of *Saturn* Vehicle *C-1* and *C-1B* at NASA headquarters.

Thomas R. Henderson: Appointed director of marketing for the Electronic Systems Div. of General Time Corp., Stamford, Conn.

Maj. Gen. Harold E. Watson (USAF, ret.): Joined General Electric Co.'s Defense Programs Operation, Washington, D.C.

Frank J. Kiernan: Appointed director of industrial planning for General Precision, Inc., Tarrytown, N.Y.

Stephen A. Prusik: Assigned Washington, D. C. representative of Aerojet-General Corp.'s Astrochem Operations.

Stanley J. Kayes: Appointed chief engineer for Optical Gaging Products, Inc., Rochester, N.Y.

Theodore J. Goldan: Appointed manager of the systems Analysis Program for the Defense Communication Agency, International Telephone and Telegraph Communications Systems, Inc., Paramus, N.J.

Forrest G. Hogg: Named manager for NASA programs, Motorola, Inc.'s Military Electronics Div., Washington, D.C.

Frank J. Owens: Appointed director of assembly and checkout of the fifth wing of Air Force *Minuteman* missiles by the Boeing Co., Seattle, Wash.

Roland Haskins: Joined Packard Bell Electronics, Los Angeles, as manager of product sales, Space and Systems Div.

C. W. Schott: Named corporate director of management systems and organization for North American Aviation, Inc., El Segundo, Calif.

Vernon L. Grace: Appointed director of reliability technology at Northrop Corp.'s Ventura, Calif., division.

William Pentland: Appointed vice president-director of manufacturing Therm, Inc., Ithaca, N.Y.

Edward D. Sherman: Appointed plant production manager of Eldorado Electronics, Berkeley, Calif.

Stanley D. Zemansky: Appointed vice president of administration for the Kollsman Instrument Corp., Elmhurst, N.Y.

Douglas Y. Smith: Promoted to vice president and general manager of Radio Corp. of America's Electronic Components and Devices Div., New York City.

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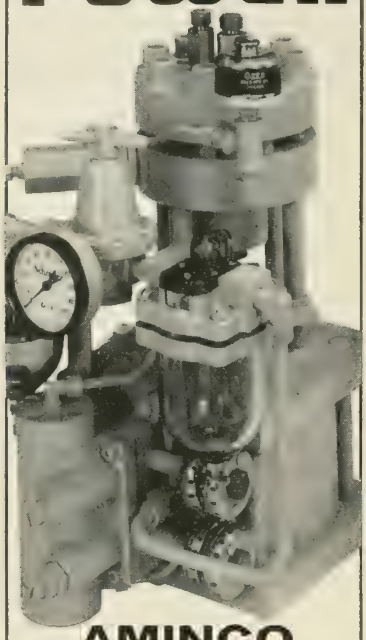
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MARCH

American Society for Quality Control Annual Seminar, Engineers Club, Dayton, Ohio, Mar. 2.

American Society of Mechanical Engineers, Aviation and Space, Hydraulic and Gas Turbine Conference and Products Show, Statler-Hilton Hotel, Los Angeles, Mar. 3-5.

1963 Microminiaturization Congress, Sheraton Hotel, Philadelphia, Mar. 5-7.

Institute of the Aerospace Sciences National Propulsion Meeting, Pick-Carter Hotel, Cleveland, Mar. 7-8.

American Society for Quality Control, Annual Quality Control Forum, King Edward Sheraton Hotel, Toronto, Can., Mar. 9.

American Institute of Chemical Engineers National Meeting, Roosevelt Hotel, New Orleans, Mar. 10-14.

American Rocket Society, Electric Propulsion Conference, Colorado Springs, Colo., Mar. 11-13.

National Assn. of Corrosion Engineers, Annual Conference and International Congress on Metallic Corrosion and Corrosion Show, Americana Hotel, New York City, Mar. 11-15.

Instrument Society of America, National Conference on Instrumentation for the Iron and Steel Industry, Pick-Roosevelt Hotel, Pittsburgh, Mar. 13-14.

Society of Vacuum Coaters, Annual Technical Symposium on Vacuum Metallizing, Park-Sheraton Hotel, New York City, Mar. 14-15.

American Society for Quality Control, Annual Quality Control Clinic, Milwaukee Inn, Milwaukee, Wis., Mar. 15.

Institute of Electronic and Electrical Engineers, Pacific Computer Conference, California Institute of Technology, Pasadena, Mar. 15-16.

American Rocket Society and Institute of the Aerospace Sciences, Space Flight Testing Conference, Cocoa Beach, Fla., Mar. 18-20.

American Society for Metals, Western Exposition and Congress, Pan Pacific Auditorium, Los Angeles, Mar. 18-22.

Society for Nondestructive Testing, Spring National Convention, Ambassador Hotel, Los Angeles, Mar. 18-22.

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editorial . . .

The Sorrowful Year

LAST WEDNESDAY marked the first anniversary of the initial U.S. orbital flight by astronaut John Glenn, Jr.

Fittingly enough, the date was observed by turnover of the *Friendship 7 Mercury* capsule to the Smithsonian Institution for permanent display. The McDonnell spacecraft will take its rightful place in history beside the Wright Brothers' airplane and the Spirit of St. Louis.

Following the ceremony at the Smithsonian, Col. Glenn and his charming family were guests of honor at a Washington luncheon. He made use of the occasion to renew his spirited defense of the nation's space programs.

Too many people, the astronaut suggested, are inclined to ask what we will learn from our exploration of space. It is much too early to answer this question, Col. Glenn said.

"It is an exploration and I don't think any of us can see at the outset how it will benefit us," he commented.

An apt comparison was made to the Lewis and Clark expedition, and its discovery in Yellowstone of many curiosities—which today remain just that. But the expedition also found the Columbia River, which today is a major source of revenue for the salmon industry.

The exploration of space, Col. Glenn pointed out, will yield similar dividends. There will be curios and there will be valuable discoveries still unforeseen.

His argument was not unlike the magnificent speech he made before a joint meeting of Congress after last year's orbital flight (M/R, March 5, p. 54). It is probably even more necessary that these points be made this year.

Congress now is being asked to pay much of the bill for placing U.S. explorers on the Moon later in this decade. The payments must be made in advance, and the $5.7-billion NASA budget for Fiscal 1964 is substantially larger than the $3.5 billion requested last year.

Yet this will be a year in which U.S. space exploits will not be as dramatic as those of 1962. It is a year of spending and of preparation for the achievements of future years. Congress must keep the goals in mind when they pass judgment on the FY '64 budget. Col. Glenn's speech is an appropriate reminder of future benefits.

The new chairman of the Senate Space Committee was among those listening to the astronaut, and we hope Senator Anderson will carry Col. Glenn's message back to the committee and to his other colleagues on the Hill.

At the same luncheon, NASA Administrator Webb expressed himself on the value of the military contribution to the nation's space effort. We were pleased that he went out of his way to correct an earlier speaker's statement giving all of the credit for our space successes to NASA.

Mr. Webb outlined the military's part in Project *Mercury*, in providing the astronauts, the boosters, tracking facilities and recovery forces. It was a point well made. Congress must keep the military role in mind when evaluating the NASA budget. There is, indeed, both military participation and fallout of value to the military itself.

Mr. Webb was generous in his praise of the military. But we could not avoid a feeling of uneasiness throughout the day. All too plainly, a full year had passed since the initial U.S. orbital flight about the Earth. All too plainly, that year had seen the military make too little progress of its own on a space program.

No sooner has the Air Force been pushed headlong and reluctantly into a joint *Gemini* program than this very fact is being used to question the need for the *Dyna-Soar* project.

We are all in favor of the fullest cooperation in *Gemini* between NASA and the Air Force. NASA itself welcomes this.

But the end effect is that of a toppling row of dominos. Air Force is participating in *Gemini;* therefore there is no need for a *Blue Gemini* program and quite possibly no need for an extensive *X-20* project. If the *Dyna-Soar* program is to be cut back severely, the need for the *Titan III* booster must be given serious new study. Without the *Titan III* booster, the Air Force program for a manned orbital development station becomes vulnerable. Perhaps, therefore, the Air Force should join in a *MODS* program which will be assigned to NASA.

The prospect for an effective manned military space program thereby becomes dimmer than ever.

WHAT IS TRULY ALARMING is the indication that the Administration may be holding off an effective military space program in the hope that the Soviet Union will do the same. This is inherent in the "building block" approach to the development of military space technology. The suggestion is that we will develop the technology and then put it into operational hardware only if the Soviets indicate they intend to do so.

It is not yet clear whether the White House expects announcement of a Russian military space program to arrive in the form of a letter from Mr. Khrushchev or as space weapons in orbit over the U.S.

To follow the Russians is folly. We must lead them. Admittedly, the thought of a military space race is frightening. But the thought of a Soviet conquest of space is more frightening. For it would be an effective end-run around the missile standoff which looms in the future.

The Administration has been publicly outlining strategy which it hopes will lead to a concentration on military objectives in event of nuclear war rather than on cities. It has been citing the need for joint agreeement on "firebreaks" between nuclear and non-nuclear war. This is like trying to reason with a hungry wolf. We fear the same thinking is being applied to military space.

Thus, the reminder that a year has passed since John Glenn's magnificent flight becomes more an occasion for sorrow than rejoicing.

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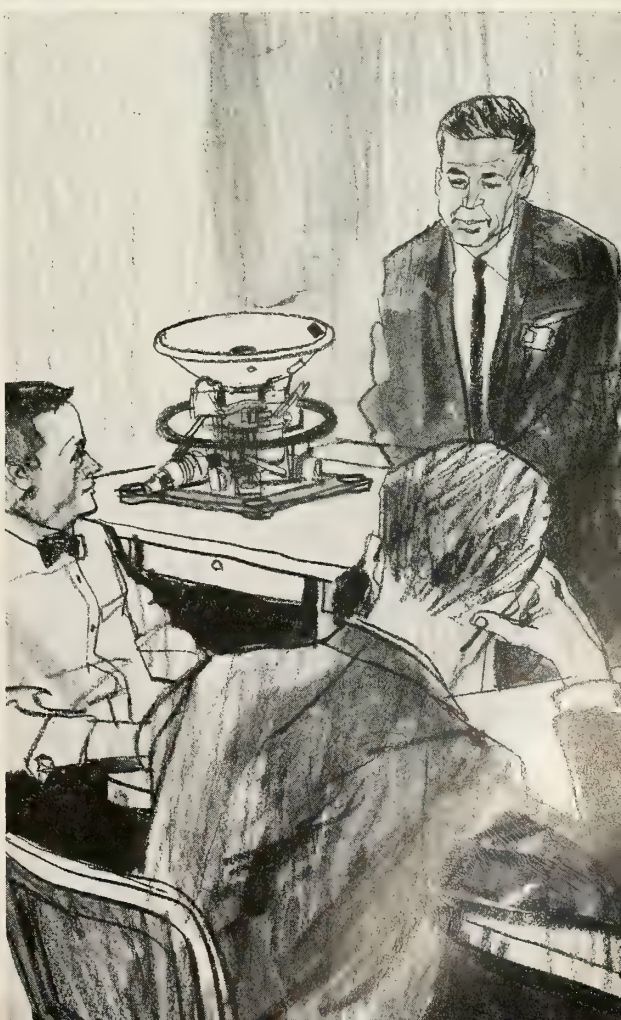
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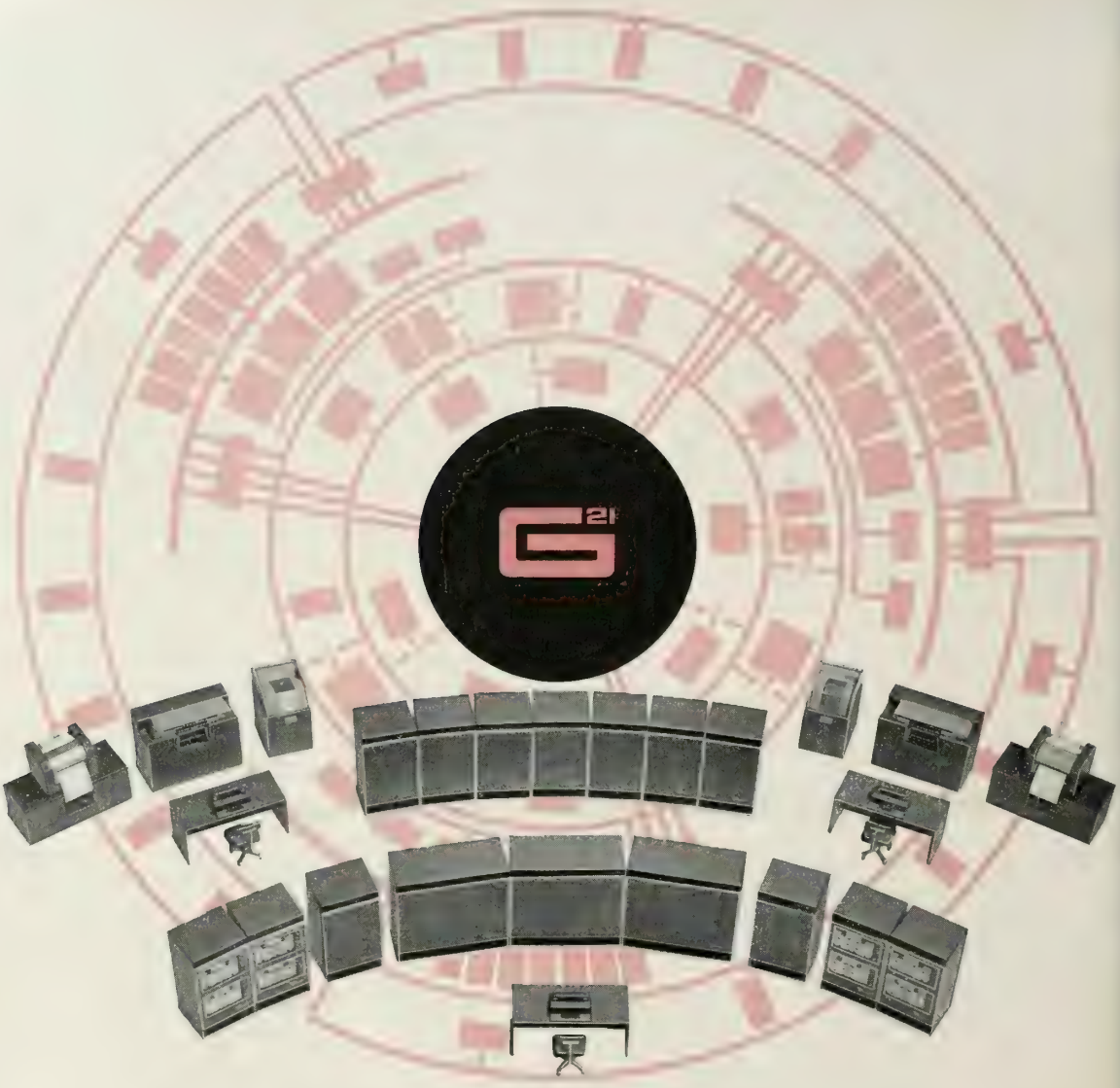
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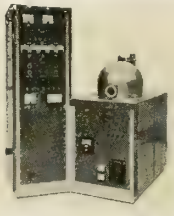
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missiles and rockets

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Senior Vice President.....**Louis C. James**
Vice President.....**Fred S. Hunter**

THE COVER



Temperature points during re-entry at 25,000 mph will be tested by calorimeters protected by heat shields like this one, made by Republic Aviation, being positioned in tunnel at NASA's Langley Research Center.

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letters

Conflict of Interest

To the Editor:

Your Feb. 18 editorial was most interesting, timely, and forthright.

Incidentally, another facet of this problem is the practice of individual Congressmen announcing contract awards.

United Aircraft Corp. has urged the Connecticut State Chamber of Commerce to endorse the following:

"Announcement of contractor awards should not be made by individual members of Congress. This practice erroneously infers that government procurement is politically motivated and thereby undermines public confidence in the integrity of both government officials and industry."

The Connecticut Chamber endorsed the proposal; its action was affirmed by the National Defense Committee of the U.S. Chamber of Commerce (of which I am a member) and will be considered by the full U.S. Chamber at its annual meeting May 1.

John Forney Rudy
Assistant to Executive
Vice President
Goodyear Tire & Rubber Co.
Washington, D.C.

To the Editor:

Your Feb. 18 editorial ("Conflict of Interest") was disappointing in that it did not measure up to the high standards that have been maintained in the past.

To lower the standards previously set by MISSILES AND ROCKETS to those you have set by your editorials can be disastrous. However, according to your published record, a military mind cannot comprehensively contribute to anything other than defense of our country and because of our professional shortcomings I apologize for the above criticisms of the editorial.

In view of this, I would expect you in the near future to correct the impression that you do not like, suspect, and, in general, question the qualifications and capability of the officers of our armed forces.

De Lair A. Clark
Colonel, USAF
Director of Systems
Air Defense Command
Command Control Defense
Systems Office

Only the incompetent ones.—Ed.

Doubts Removal

To the Editor:

Re "Beyond Reasonable Doubt . . ." (M/R, Feb. 11, p. 10), this brief report, plus *U.S. News & World Report's* six-page article recently leaves plenty of doubts in the minds of those who analyze the Administration's proferred "proofs" on one very important phase of the offensive weapon situation in Cuba—namely the "complete removal from Cuba" of offensive weapons.

Mr. McNamara's "mountain of documentary evidence refuting charges" is far from convincing for anyone from Missouri, or for any scientist or engineer to whom wishful thinking is anathema.

One may grant, from the photographic evidence, that offensive missiles and bombers were set up as an ambush for us, and that another week or two of preparation would have enabled Khrushchev and/or Castro to hurl an ultimatum at *us!* One may grant too that the missile launch pads were broken up and all the associated apparatus carried away.

If this "mountain of documentary evidence" had included a continuous, never-interrupted motion picture, which showed every single step of that "removal" from the launching sites, across the countryside, into the Russian freighters, and the departure and voyages of those ships back to Russia, one might be able to say they were removed "beyond reasonable doubt." But neither the professed evidence or the earlier photographs have resolved the very obvious doubts . . .

Earlier we were shown aerial photographs of canvas-covered, elongated cylindrical objects and boxed other objects on outgoing Russian freighter decks. To be sure, one look-like missile and one look-like bomber fuselage were exposed, and both may have been the real thing or not, since only their exterior surfaces were visible. X-ray techniques obviously could not be used . . . How then can our Administration's spokesman so assuredly insist that the 40-odd missiles and the offensive bombers were actually taken back to Russia? . . .

On explicit Moscow orders, these freighter captains denied on-deck inspection by our blockade forces, and we, naively or wishful-thinkingly, allowed their ships to slip uninspected through our fingers! . . .

(Khrushchev) left to Castro an adamant refusal of inspection in Cuba, even by disinterested UN or Red Cross authorities, thus locking the back door against discovery of his deception. And Mikoyan stayed much too long with Castro not to have been cooking up some deviltry for us!

We, like naive asses, fell for this ruse, pulled out our blockade forces, and dragged the crisis-corpse under the rug! . . .

In truth, no one really knows where those known offensive weapons are, or how many others are secreted in Cuba. No aerial camera can see into caves or submarines, or through cleverly contrived, innocent-looking screens of camouflage.

We are told that, even if there were hundreds of offensive missiles in Cuba, these are useless without massive concrete launching pads. How can we be so sure of this when we ourselves have our underground *Minutemen,* and our *Polaris* missiles in the tubes of our submarines? . . .

Benjamin F. Miessner
Miami Shores, Fla.



If you seek involvement in the creation of a new missile center, you should investigate these and other unusual ground-floor opportunities at Aerospace Corporation's new San Bernardino, California, facilities.

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In order to qualify for these and other positions, you should have at least five years' experience and, preferably, an advanced degree. Applicants are invited to contact Aerospace Corporation, an equal-opportunity employer. Please write to Mr. Robert Durant, Room 105, P. O. Box 249, San Bernardino, California.

AEROSPACE
CORPORATION



An elegant, but tiny refrigerator, utilizing the Nernst-Ettingshausen effect, has been demonstrated in the Solid State Physics Laboratories at Lockheed Missiles & Space Company. This type of cooling is applicable below 200° Kelvin, where thermoelectric cooling is no longer efficient. It shows particular promise for space application because of the reliability inherent in its all-solid state construction.

In the Nernst-Ettingshausen effect, heat is pumped as a result of an electrical current flowing in a magnetic field. The heart of the present device is a bismuth antimony single crystal. Other crystal systems are also being investigated.

This thermomagnetic cooling device is one of the results of the Lockheed research program in transport phenomena in solids.

Another investigation concerns the quantum theory of the electronic structure of crystals. An ingenious computer program has been devised for determining the essential features of the energy band structure of a wide variety of crystals. Results for a given case can be obtained in an hour or less. Conclusions drawn from the theoretical solution elucidate many of the electronic properties of crystals, and have widespread significance.

Lockheed scientists and engineers are also studying: Electron spin echo phenomena; the interaction of electrons with microwave phonons; coupled traveling waves in crystals; semiconductor lasers; antiserromagnetic resonance; various theoretical and experimental aspects of superconductivity.

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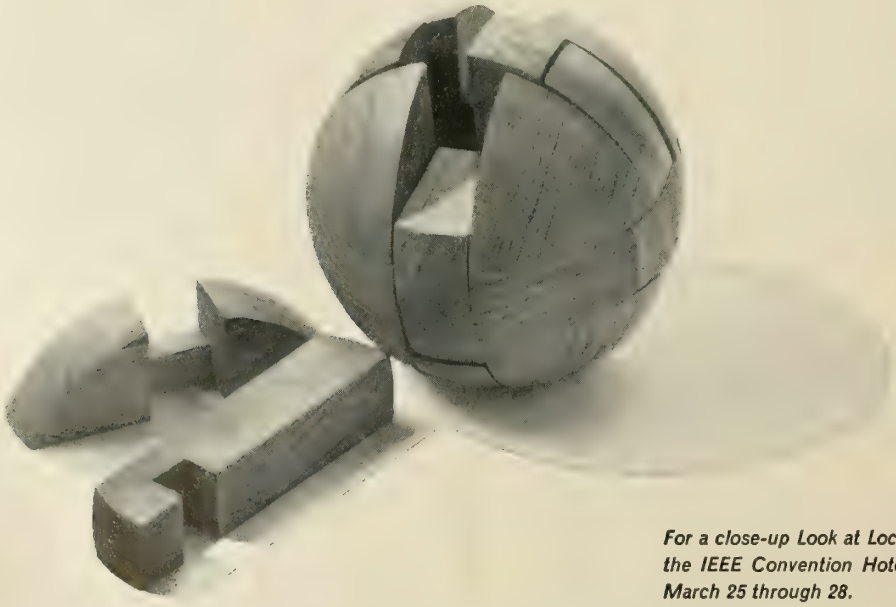
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The Countdown

WASHINGTON

MOSS Planning Proceeds

NASA's Manned Spacecraft Center in Houston continues to push ahead with plans for a *Manned Orbiting Space Station*. It has called for bids on a study to estimate requirements for program definition, preliminary design and utilization of the station and a logistics spacecraft compatible with the station and planned launch vehicle. Bids are due March 20.

Dixon About to Step Down

NASA's Deputy Associate Administrator Thomas F. Dixon is expected to resign his post in the near future. He joined NASA after many years with the Rocketdyne Division of North American Aviation, Inc.

Space Agency Censorship

A number of NASA contractors at a recent technical meeting complained that the space agency is putting a clamp on what they can discuss in technical papers. The tactics so infuriated one contractor that he dumped the whole thing in NASA's lap—and a NASA official delivered the presentation.

SAMOS High-Diving Headache

One big problem in the *MIDAS/SAMOS* program is recovery of data capsules, COUNTDOWN has been told. The Air Force reportedly is tired of watching its funds plunge into the Pacific, and the lack of hard data to work with may be cutting the value of the systems. West Coast officials decline to say where two Pacific Missile Range ships are now located, giving rise to speculation that every effort is being made to recover capsules by seaborne and airborne forces.

Reds Stick with Vostok Booster

NASA officials report that Russia is trying to improve its upper-stage vehicles but seems to be continuing to use the same first stage that boosted the *Vostok* flights. They say intelligence secrecy prevents them from revealing the basis for this belief.

INDUSTRY

Super-Genie Dies A-borning

Cancellation of the *Super-Genie* by the Air Force reportedly caught Douglas Aircraft Co. by surprise, since first public mention of the missile is in the company's brand-new annual report. *Super-Genie* was basically the same as the MB-1 *Genie*, but had a new fuzing system for the nuclear warhead.

Swedes Swell Sidewinder Sales

Philco Corp.'s Communications and Electronics Division will now build *Sidewinder 1-A* air-to-air missiles for Sweden, under a U.S. Navy contract.

Besides Sweden, foreign nations now buying *Sidewinder* for their defenses include Britain, West Germany, Australia, Spain, Denmark, the Phillipines, Italy, Japan, Switzerland, Thailand, Nationalist China and the Union of South Africa.

New Causeway Bids at Cape

The Corps of Engineers will open bids March 26 for dredging fill to make a four-lane causeway linking NASA's Merritt Island lunar launch area at Cape Canaveral with the mainland. Target date for completing the causeway is October, 1964.

This causeway, which will bridge Indian River, will connect with another now being built across Banana River. The two roadways will provide a direct route from Canaveral's present industrial area through the NASA industrial complex to the mainland and an airport.

INTERNATIONAL

TSR.2 Missile Fizzle?

Britain's new atomic weapon for its TSR.2 strike plane is now labeled another defense miscalculation by some quarters in London. The new missile was recently announced by the government with great fanfare, and some correspondents called it a "wonder bomb." But Air Chief Marshal Sir Philip Joubert, former commander of the RAF's Coastal Command, who at first welcomed the announcement, has now described it as "a complete fraud on the British public."

The new missile has also been called "little more than an airborne artillery shell." It was officially described as a further development of an existing weapon, and is now thought to be no more than a free-falling delayed-action nuclear bomb.

France Presses Atomic Space Effort

France plans to build small SNAP-type nuclear generators weighing less than 5 lbs., and may use them for space research. The National Atomic Research Center (CEA) will develop radio-isotopic electric generators, electric propulsion by plasma, and will conduct research on fission space reactors and light- and heat-resistant materials such as beryllium. Meanwhile, the Laboratoire de Recherches Balistiques et Aerodynamiques of Vernon is working with SNECMA on a heavy missile equipped with a nuclear propulsion system.

Britons Queue Up for Polaris Work

Representatives of both staff and manual workers employed by Britain's Atomic Energy Authority have approached the Ministry of Science with a proposal that the AEA's Capenhurst establishment in Cheshire, England, be put to work on development of *Polaris* submarines. They're worried about the future of the workers now that the U.K. will be building fewer nuclear products for defense.

Martin Gets Titan III Money

The Air Force has awarded the Martin Co. $50.2 million for production of *Titan III,* and simultaneously disclosed plans to use the workhorse to boost orbiting space laboratories and ferry craft to supply them. This is the first production authorization for *Titan III.*

The *Manned Orbital Development Stations* and advanced *Gemini* spacecraft would work together as base and logistical vehicles, the Air Force said. Total cost of the Martin contract is expected to be about $285 million, bringing the program total to more than $800 million.

ComSat Corp. Adds Two

Leo D. Welch, chairman of the board of the Standard Oil Co. of New Jersey, and Air Force Undersecretary Joseph V. Charyk (M/R, Jan. 21, p. 9) have been named to the board of the Communications Satellite Corp. by President Kennedy.

The board will soon name Welch chairman and chief executive of the ComSat Corp. at a salary of $125,000 and Charyk will be named president and principal operating officer at $80,000 annually.

Both appointees, along with the 12 remaining members of the corporation board, are expected to be confirmed by the Senate Commerce Committee sometime after hearings on the nominations, which begin March 11.

The President originally appointed 13 incorporators, who were expected to automatically become members of the operating board when it would be established; but one member, Philip Graham, president of *The Washington Post,* resigned because of ill health. With Welch and Charyk added, the board now stands at 14 members.

Charyk, an Eisenhower appointee, has been with the Air Force since January, 1959, after serving as general manager of the Space Technology Div., Aeronutronic Systems, Inc. Previously, he was director of the Aerophysics and Chemistry Laboratories of Lockheed Aircraft.

The corporation announced Feb. 27 that it has completed arrangements with a group of 10 banks to borrow up to $5 million to meet financial requirements before the initial public issue of stock.

An initial borrowing of $500,000 is expected to be made immediately, with additional funds to be borrowed from time to time as needs develop.

Shots of the Week

Minuteman, Nike-Zeus, Polaris and *Pershing* missiles all scored successes last week.

• The *Minuteman* was fired 3000 mi. down the Atlantic Missile Range from a Cape Canaveral silo Feb. 20. An Air Force spokesman described the shot as a success, but did not indicate whether the ICBM was the Wing I or more advanced Wing II type.

• The Army conducted a successful development launch of the Western Electric *Nike-Zeus* Feb. 20 at White Sands Missile Range, N. M. All three solid-fueled motors of the antimissile missile were fired during the flight.

The *Zeus* accepted and correctly executed control commands issued by its ground guidance center, meeting all test objectives.

• At least one Lockheed *Polaris A-2* was fired from the submerged U.S.S. Thomas Jefferson Feb. 21 off the east coast of Florida. The flight was scheduled for 1400 mi.

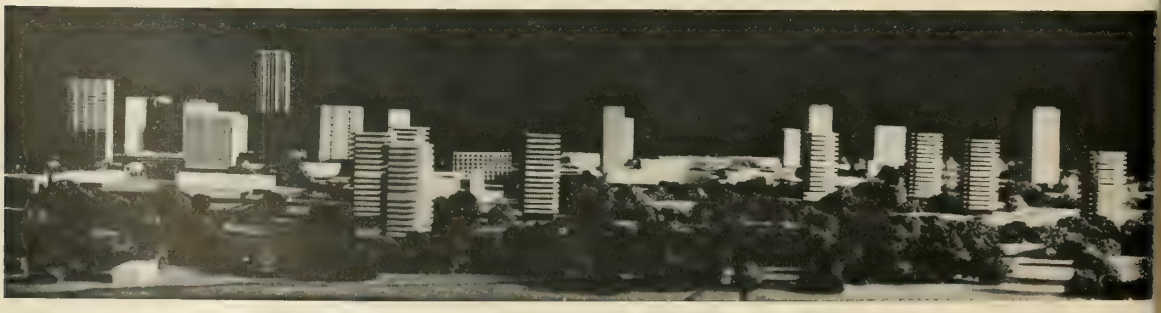
• A Martin *Pershing* met all test objectives in a Feb. 25 shot from Cape Canaveral.

A full set of tactical ground-support-equipment was used to prepare, erect and fire the two-stage, solid-fueled missile from a mobile launcher parked on a sloping sand bank. The shot was intended to further evaluate guidance and propulsion systems and warhead components.

Zuckert Strikes Again

Air Force Secretary Eugene M. Zuckert has entered a plea for a military space program based on two objectives: 1) to build a defensive capability in "this new area of vulnerability to attack" and provide the ability to support terrestrial forces of the U.S. in face of any enemy threat; and 2) to provide capability to deny the enemy uninhibited exploitation of space while providing protection for U.S. scientific activities.

Significant military space possibilities are now "clearly apparent," he told the House Armed Services Committee, and took a jab at the Defense Dept.'s "technological building block" concept. It is "the ready military capability, not the technological base that accomplishes deterrent," he said adding that it takes years to get from the development stage to an operational system.



Future Skyline of Houston's Space-Age Community

IN 15 YEARS, Del E. Webb Corp. says, this is the way the skyline of its Clear Lake City development may look. The massive (15,000-acre) community near NASA's Manned Spacecraft Center at Houston will have carefully planned areas devoted to research, industry, homes, recreation and commercial establishments including hotels. Actual development of the area is being done by the Friendswood Development Co., which is jointly owned by the Webb Corp. and Humble Oil & Refining Co.

AF Chief of Staff Gen. Curtis LeMay later said the area of military space includes "the sphere bounded by synchronous orbits."

M-2 Glider Tests Due

NASA will begin glider flight tests next month of a wingless re-entry vehicle under study for post-*Apollo* missions.

The *M-2* vehicle is a slender, half-cone lifting body, with no wings. It has a blunt nose, boat-tailed aft section, vertical fins, and small "elevon" control surfaces.

(The new program was revealed in detail exclusively by MISSILES AND ROCKETS, Feb. 11, p. 26.)

NASA said pilots of the *M-2* vehicle could have more than 1000 miles of lateral maneuverability after they reenter the atmosphere.

NASA Orders More Deltas

NASA has ordered 14 more *Delta* boosters from prime contractor Douglas Aircraft Co.

The announcement was made at Cape Canaveral, Fla., as the NASA Group Achievement Award was presented to the *Delta* Project Group of the Goddard Space Flight Center, which has managed the project for NASA.

The order brings to 40 the number of *Deltas* NASA has purchased since the program began in April, 1959. When final contract details are completed, the new *Delta* order is expected to cost about $18.6 million.

In addition to the *Delta* hardware, NASA officials are also negotiating a contract with Douglas to cover launch services for the new *Deltas*. This contract, expected to be signed soon, will total about $5 million.

Since May, 1960, 16 *Deltas* have been fired from Cape Canaveral. The booster has performed flawlessly in all but the first flight.

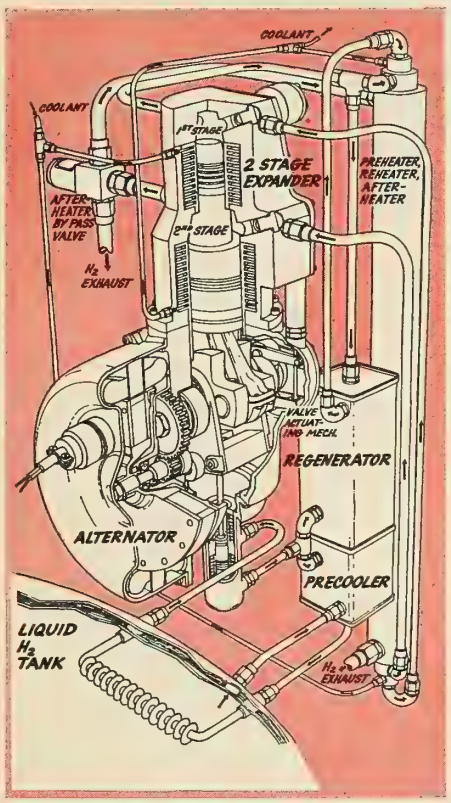
MSFC Lets Saturn Support Contract

NASA's Marshall Space Flight Center has let a $3,382,037 contract to Pearce and Gresham Co., Decatur, Ala., to provide a support system and building for the *Saturn V* booster static-test facility at MSFC.

Work will include construction of a helium system, a high-pressure nitrogen gas system, a propellant-distribution system and a support building for engine handling, maintenance and repair.

Contract calls for the work to be completed by February, 1964.

A RELIABLE SPACE POWER AND THERMAL CONTROL SYSTEM FOR LUNAR EXPLORATION



THE CRYHOCYCLE-R is one space power system now in the advanced test phase at Sundstrand Aviation - Denver. This system is unique in that it eliminates the problems of radiator development, orientation and protection, and the high weight of water evaporative cooling systems. Normally wasted energy (even the metabolic heat of the astronauts) is recovered and used. The working fluid, hydrogen, is heated both between stages and in the cylinders, significantly reducing the specific propellant consumption and providing simultaneous power generation and thermal control. ■ Because it provides both power and cooling, independent of the vehicle's external environment, the CRYHOCYCLE-R permits the development of a single lunar vehicle for exploration of any part of the moon, and at any time of the lunar day or night. ■ Because it operates on cryogenic propellants (and can utilize "boil-off") it also has many advantages for parking and rendezvous applications. ■ For an over-all picture of Sundstrand's broad experience in chemical and solar dynamic space power systems, send a request to our Applications Engineering Department on your business stationery. ■ If you would like to work on the Sundstrand engineering team finding practical solutions to challenging space problems, write to: Personnel Director,

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New Mariner Planning Pushed

Experiments for 1964 Mars flight to be chosen in six weeks; decision near on development of heavier craft for 1965-66

by Hal Taylor

NASA HAS MOVED to finalize plans for future *Mariner* flights following the release of data from *Mariner II* indicating that surface temperatures of 800°F preclude life as we know it on Earth's nearest neighbor.

A spokesman for the Office of Space Sciences said the selection of experiments for a 1964 *Mariner* flight to Mars will be made in six weeks.

He also told MISSILES AND ROCKETS a decision will be made in the near future on the advisability of moving ahead with development of a heavier-weight spacecraft for flights to both planets in 1965-66.

The principal uncertainty holding up the program is the availability of the *Centaur* booster. While it is scheduled for operational flights in early 1964, it has still not chalked up a successful flight. Another factor, the spokesman said, is that Jet Propulsion Laboratory and the Goddard Space Flight Center have come up with slightly differing proposals for the spacecraft and a selection between the two must be made.

The latest developments in the unmanned interplanetary exploration program came against the background of almost unlimited information revealed by *Mariner II* which flew within 21,000 miles of Venus on Dec. 14.

Besides recording the excessively hot surface temperature, infrared and microwave radiometers aboard the spacecraft reported that the planet is covered by cold, dense clouds with temperatures at the center of about −30°F.

The instruments made three scans of Venus during a 35-minute period—one on the dark side, one on the light side, and one across the terminator line which separates the two.

• **Close look**—Based on the result of those experiments, and other Earth-bound studies of Venus, NASA gave the following preliminary description of the Venus surface and atmosphere.

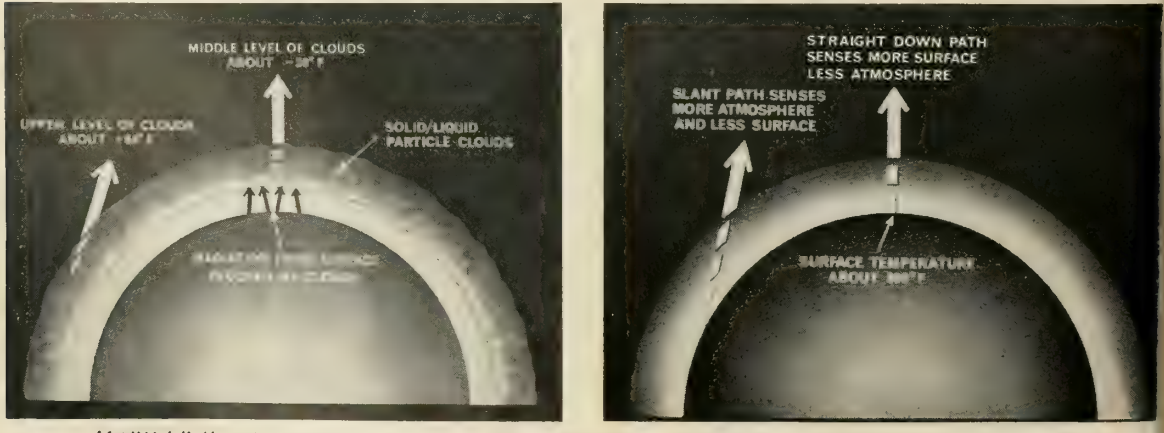
The surface is dry, sandy, overcast and very hot. The average 800° temperature was recorded on both the light and dark sides of the planet.

A heavy cloud with a ceiling of 45 mi. covers the planet. The cloud layer is estimated to be 15 to 20 miles thick, with temperatures of about 200°F at the bottom and −30°F at the center.

Officials said the clouds appear to be composed of hydrocarbons. They described it as a kind of smog.

Data from the two radiometers led NASA officials to assert that no life—at least as we know it—could exist on Venus's surface.

Homer E. Newell, director of the Office of Space Sciences, declared, however, that some biologists think some form of life may exist in the much colder atmosphere. He said balloon experiments to study life forms at high altitudes above the Earth eventually



MARINER II studies included (left) infrared temperature study of clouds, (right) microwave temperature study.

could lead to design of experiments to make similar studies in Venus's atmosphere.

Results of other major Mariner experiments include:

• **Telecommunications**—During the 129-day flight, over 65 million bits of information were sent back to Earth with the use of only three watts of radio frequency. When contact was lost with the spacecraft on Dec. 29, communication was being sent back to Earth over a distance of 53 million miles. NASA said that this proved that good, reliable deep-space communication is possible within the solar system.

• **Fields and Particles**—There is a continuous solar wind "like the blast of a rocket nozzle" in interplanetary space. The density of the plasma is very, very low—in the neighborhood of 10-20 particles per cu. in. Its velocity varies from 200-500 mi./sec. and its temperature approaches one million degrees.

• **Tracking**—NASA said precise, two-way Doppler tracking of *Mariner II* during the flight will enable scientists to get more accurate figures for the masses of Venus and the Moon, precise locations of tracking stations on Earth, and the value of the astronomical unit. It has also made clear that simple Earth-based radio guidance techniques will remain competitive with on-board guidance measurements until extremely precise target error control is desired.

Two-way Doppler is a method of measuring radial velocity of a spacecraft, using the well-known Doppler shift in frequency in a radio signal between two moving objects.

During the flight, more than 22,000 two-way Doppler data points were taken. Velocity changes on the order of one-tenth of one inch per second were measured.

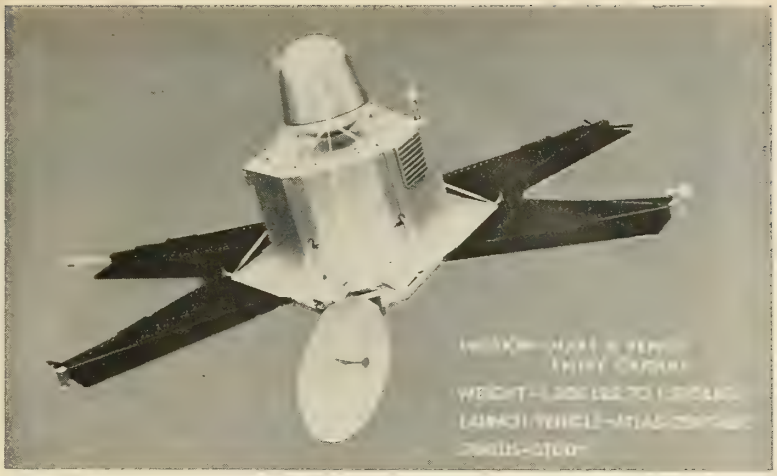
Using the data, it was possible to calculate exactly how the gravity of Venus affected *Mariner's* trajectory. Using Earth-based means, scientists have estimated Venus's mass at 0.8148 of the Earth with a probable error of 0.05%

The *Mariner* data have the potential of determining the Venus mass with a probable error of only 0.005%.

Another significant result was the establishment of a more exact location for the Goldstone, Calif., tracking station. Previously, it had been known to within 100 yds. *Mariner* data will cut the uncertainity to 20 yds.

Using the same method, it is hoped that the mass of the Moon—now known to a certainity of 0.1%—can be fixed with an even smaller margin of error.

The Astronomical Unit—the mean distance between the Earth and Sun—is used as the yardstick of the solar system. Data from classical astronomical



NASA DRAWING of one concept of the Mariner Venus-Mars lander spacecraft.

observations have derived a value of the AU which is 50,000 mi. different from the value derived by Venus radar bounces in 1961. The radar established AU is 92,956,220 mi., plus or minus 300 mi. The optical AU is 50,000 mi. smaller.

The *Mariner* tracking data now provide an additional radio determination which will help resolve the conflict between the radar-established AU and the AU calculated by optical measurements.

• **Cosmic dust**—The experiment was designed to measure the flux of interplanetary dust particles between Earth and Venus. The system was capable of detecting dust particles with masses as low as 1.3×10^{-10} gm (about one trillionth of a pound). Over 1700 hours of reduced data have been received. During this time only two dust-particle impacts on the sensor plate were recorded. The dust-particle flux indicated by this measurement is approximately four orders of magnitude less than that observed near the Earth from similar experiments on satellites. Both of the events occurred in deep space, and no impacts were recorded in the vicinity of Venus.

• **Magnetometer**—If Venus has a magnetic field, it was too weak to be picked up by the *Mariner* experiment as the spacecraft made its 21,000-mi. fly-by.

• **Radiation**—The high-energy detectors maintained a counting rate of only one per second. Scientists said that this is a much smaller radiation dose than that encountered around Earth where, they said, the instruments would have chalked up a counting rate of several thousand times a second.

• **Radar bounce experiment**—This was conducted by the Goldstone tracking station in conjunction with the *Mariner* flight. The measurements indicate that the planet rotates very slowly, so slowly that it may very well be keeping the same side facing the Sun.

NASA noted that all of the results of the flight are still in the preliminary stage. They said further and more detailed results would be released as they become available, but gave no indication when such announcements could be expected.

In discussing the future *Mariner* flights, the Space Science spokesman said that it is expected that the Space Science Steering Committee will select experiments for the 1964 Mars fly-by in about six weeks. He said that NASA currently plans to have a biological experiment on hand to test for life on the planet, and that this probably will include some sort of TV camera or other visual means.

Other experiments which he said are almost certain to be on the spacecraft include some form of a radiometer, and interplanetary measurements of particles and solar plasma.

NASA had originally planned to use a heavier, 1000-lb. *Mariner* spacecraft for the 1965 and 1966 flights to Venus and Mars respectively. The flight plan called for the spacecraft to inject a capsule to land on the surface of both planets.

A go-ahead still has not been given to the project, principally because officials are not certain that *Centaur* will be available to serve as its booster.

The spokesman said a decision will be made in the near future. If it is decided to forego the 1964 Venus opportunity, the next launch window will occur in 1967. Officials feel *Centaur* is certain to be ready for a December, 1966, Mars shot. ■

$329 million for Minuteman . . .

AF Details $1-Billion R&D Request

Titan would get $25.1 million, Atlas only $700,000; some $40 million sought for exploratory missile work

AIR FORCE R&D funding requests totalling over $1.06 billion have been presented to Congress by Lt. Gen. James Ferguson, AF deputy chief of staff for research and technology.

Testifying before the House Armed Services Committee last week, Ferguson said AF wants $329 million for *Minuteman* R&D, $25.1 million for *Titan* R&D, and only $700,000 for *Atlas* R&D. Exploratory missile development—including nuclear weapons and effects, rocket propulsion and electromagnetics—would cost about $40 million.

The Air Force also is asking $324.6 million for *Titan III* R&D during FY '64 and $125 million for *Dyna-Soar*.

Advanced development projects were also detailed, with *Pluto* listed at $15 million, stellar inertial guidance at $20 million, advanced ICBM technology at $15.5 million, and high-energy solid-propellant rocket motors at $2.5 million.

Under engineering developments *MMRBM* was put down for $143.1 million, *Nike-Zeus* targets $3.6 million, and advanced ballistic re-entry systems $218.6 million.

Management and support funds requested included $207 million for operation of the Atlantic Missile Range and $30 million for Space Technology Laboratories.

The funding requests for *Atlas* will be used to complete a few remaining test programs. The FY '64 funding for *Titan* will complete the development program; *Titan II* testing is scheduled for completion early in the fiscal period, with launchings from both Atlantic Missile Range and Pacific Missile Range.

R&D on *Minuteman* will reach its peak in FY '64. The $329-million budget request would fund two principal efforts: a new second-stage engine to increase range and payload; an improved guidance system to reduce the CEP.

"We have found it very costly to introduce added flexibility into existing missiles," an AF spokesman said during the hearing.

Twenty-five separate projects have been designated "exploratory development" in the missile R&D category, including studies of vulnerability of nuclear systems, investigation of promising new concepts in solid rocket engines in an effort to achieve greater thrust efficiency, and electronic work in computer technology to insure more reliable and efficient operation under space conditions.

In explaining requests for funding the *Pluto* supersonic low-altitude missile, it was noted that Marquardt Corp. will be working on nuclear and chemical propulsion technology and Ling-Temco-Vought on the nuclear vehicle components. Work in these areas in FY '64 will be confined to exploratory studies, tests and feasibility investigations.

• **MMRBM guidance**—Stellar inertial guidance requests are for development of two techniques—one for the *MMRBM* and another for precise orbital navigation. The basis for the *MMRBM* system will be stellar tracking during the boost phase, with flight tests for the guidance system due to begin during FY '64. In the orbital navigation approach, stellar tracking after boost is the main concept. Lab and rocket sled tests will begin in FY '64.

Advanced ICBM technology funds will be used to explore size, range, guidance and bases for the next generation of ICBM's. No contractor has been selected for R&D in the area of high-energy solid rockets thus far, and work in this field will stress longer ranges and increased payloads.

The two-stage, solid-propellant *MMRBM* will be designed for transport on a single vehicle, capable of deployment on primary or secondary roads in Europe and elsewhere within the Free World.

Successful penetration of enemy defenses is the main aim of the advanced ballistic re-entry system work, for which $218.6 million is asked. Various penetration systems will be analyzed and war-gamed against an assortment of defenses.

Spokesmen noted that in the *Aerospace Plane* concept, the Air Force is seeking a manned space vehicle capable of taking off from a standard runway, performing a mission in space, and returning for a routine airfield landing. Use of the liquid air cycle engine is expected. Marquardt is doing preliminary work. ■

First Gemini Flight May Be Year Away

A USUALLY well-informed NASA official declares that the first Project *Gemini* flights have now slipped to 1964.

The official told MISSILES AND ROCKETS the first unmanned suborbital flight will not be made until early next spring. It is hoped, he said, that the first manned orbital flight can be attempted by late next year.

The report was denied officially by NASA headquarters, which held to a "before the end of 1963" target for the ballistic shot. D. Brainerd Holmes, director of Office of Manned Space Flight, told a House Space Committee that the flight would be made "around the end of the year."

While the NASA official did not detail the cause of the slippage, funding problems have plagued the program recently. This could become even worse if Congress follows its usual pattern and holds off giving final approval to the Fiscal '64 budget until late in the year. Minor technical problems in the paraglider landing system have also been admitted by the space agency.

Originally, *Gemini* flights were scheduled to begin in mid-1963, with a manned orbital flight before the end of this year.

In a related area, Air Force studies seem to restrict one experiment planned for *Gemini* flights. This called for permitting the astronauts to leave the spacecraft and go out into space. This can be done, the Air Force studies show, only if a propulsion unit is strapped to the astronaut.

Attempts to reel or jerk an astronaut back into the spacecraft with a rope probably would kill him if he were 300 or 400 ft. away. ■

NASA Administrator testifies . . .

Fund Cuts May Forfeit Moon Race

Webb tells House NASA's budget already shows austerity; Seamans outlines alterations in space agency's R&D programs

EMPHASIZING the "austerity" of 1964 NASA fiscal proposals, Administrator James E. Webb has warned Congress that budget cuts would have a direct impact on the race to land a U. S. astronaut on the Moon before the Russians.

Replying to a question put to him by Rep. Thomas M. Pelly (R-Wash.) an advocate of reduced government spending, Webb stated that 90% of the funds NASA is asking for Fiscal 1964 are to cover commitments already made to contractors. He said a budget reduction would force the agency to stretch out some of the contracts.

Pelly had asked during a House Space Committee "posture" hearing Feb. 25 whether the agency could accept a $5.2-billion FY 1964 budget total, the minimum figure discussed during Administration funding deliberations last fall. The committee is being asked to authorize a total $5.712 billion in new spending.

Detailing changes made in the Fiscal 1963 program since last year, Associate Administrator Robert C. Seamans, Jr., testified that a total of $174.3 million has thus far been reprogrammed among NASA research and development programs. In construction, Seamans said, Fiscal 1963 projects valued at $105.1 million were deleted; others, estimated to cost $47.4 million, were changed in scope; and still others, worth $103.7 million, were added to the program.

Webb noted that these actions had provoked criticism, particularly in the Senate, because funds programmed for expenditure in one state were later allocated to projects in another.

• **Alterations**—Specific changes in R&D programs listed by Seamans included:

—A reduction of $80.6 million in the manned spaceflight allocation originally proposed caused a "reduction" in the post manned lunar landing build-up, including deferral of *Nova* development, and a slow-down in M-1 engine development.

—Increases in manned lunar landing costs, however, offset over half the $170-million decrease, he said. These included additions of $14.5 million and $42.6 million for *Gemini*. *Apollo* costs are running $37.3 million under last year's estimate, Seamans said.

—A $43.8-million net increase in the space science programs is largely attributed to additional testing and engineering effort required in the *Centaur* program. He also noted reductions of $7.4 million for geophysics and astronomy projects and $11.6 million for lunar and planetary exploration not related to *Ranger* or *Surveyor*. Seamans said $13.9 million has been set aside to get a new biological satellite program under way.

—A $35.2-million reduction in ComSat funding resulted from the decision to focus attention on problems with high-altitude synchronous satellites.

—A $13.3-million increase in funding of advanced research and technology programs was needed to purchase three F-104's, a Lockheed JetStar and a helicopter for use in aeronautics.

—Nuclear rocket funding was reduced by $11 million because the RIFT program has been moving more slowly than anticipated. ■

Boeing Wins NASA's Largest Contract

NASA HAS ANNOUNCED the signing of its largest contract in history—over $418 million to the Boeing Co., for the first stage of the *Saturn V*.

The contract calls for design, development, and manufacture of 10 flight boosters and one ground-test vehicle.

Total value of the contract is $418,820,967. Its value will eventually be much higher, because NASA is certain to launch far more than 10 of the boosters.

NASA announced Dec. 15, 1961, that it would negotiate with Boeing for this contract. Preliminary development of the booster has been in progress under an interim contract since December, 1961, at a cost of about $50 million.

Most of the work will be at NASA Michoud Operations in New Orleans, where assembly is to take place. Boeing will also employ forces at its plants at Wichita, Kan., and Seattle, at Huntsville, at Mississippi Test Operations and at NASA's Launch Operations Center.

The S-IC first stage will be 138 ft. long and 33 ft. in diameter. It will have a dry weight of almost 150 tons and a propellant capacity of 2200 tons. It will be powered by five Rocketdyne F-1 engines arranged in a square pattern with the outside four gimballed and the center engine fixed. Each engine provides 1,500,000 pounds of thrust for a total of 7,500,000 pounds.

The first unit to be produced by Boeing will be a ground-test vehicle, to be delivered to the Marshall Center. Boeing's initial flight units also will be brought to the MSFC for static tests, until test stands at the Mississippi Test Operations are completed.

Under terms of the contract, Boeing will assist in launching the booster from Canaveral. NASA retains transportation responsibility to the testing and launch sites.

• **Other stages**—The S-II second stage will be 82 ft. long and 33 ft. in diameter. It will have a dry weight of 36 tons and a propellant capacity of 465 tons. Five Rocketdyne J-2 engines will provide a total thrust of one million pounds. The propellants will be liquid oxygen and liquid hydrogen. As in the first stage the outer four engines are gimballed and the center engine is fixed.

The North American Aviation Space and Information Division was selected as the second-stage contractor and was awarded an initial contract in October, 1961. The stage will be assembled at a new plant now under construction at Seal Beach, Calif.

The third stage, the S-IVB, will be 70 ft. long and 23 ft. in diameter. The dry weight of the S-IVB will be 10 tons and it will have a propellant capacity of 115 tons. One J-2 engine will provide a thrust of 200,000 pounds in flight.

Douglas Aircraft Company was selected in December, 1961, as prime contractor for the S-IVB stage. Manufacturing and assembly will be done at Douglas' new plant in Huntington Beach, Calif. ■

By the Air Force . . .

Airship Studied as Booster Carrier

Concept calls for dirigibles to be leased to bypass road and barge problems of hauling outsize structures

by Frank G. McGuire

USE OF DIRIGIBLES to transport outsize cargoes such as space boosters is being actively considered by the Air Force in an effort to eliminate problems encountered in highway and barge transport systems.

Expressions of interest in the concept have been received from a number of companies, and AF Systems Command has recommended that the Defense Dept. consider employing the huge airships to transport large rockets, radar antennas, and even complete buildings from fabrication site to launch areas or other facility.

There is no specific budget item for the airships, but one proposal in AF hands would have the leasing firm build the airship at its own expense and operate it for the national space program for a monthly rental of $545,776. This figure, quoted by the Claude C. Slate Co., Glendale, Calif., would cover AF use of a metal dirigible on a 24-hour basis for hauling large boosters or other cargo around the country.

In addition to Slate, Goodyear Aircraft and American Machine and Foundry have shown considerable interest in the concept. Goodyear would use a fabric-covered hull, while AMF's ideas were not detailed.

The Slate Co. proposal, on which greatest detail is available, involves the SMD-100, a metal dirigible of 570-ft. length capable of lifting 250,000 lbs. of cargo and carrying it cross-country at 100 mph. Slate says it would build the ship with its own funds and lease it to the government, with AF supplying engines, helium, navigation, communications and other electronic equipment, as well as auxiliary power units. Slate would provide crews, hull maintenance, and other services as part of the five-year contract, which would be based on a five-year write-off.

The metal hull would consist of strips of pre-shaped contours, each the length of the hull, providing a gas-tight, rigid outer skin. Slate says it would have greater strength, aerodynamic superiority, gas capacity, and all-weather flying ability than any other dirigible built previously.

The 177-ft.-dia. hull would hold 8,600,000 cu. ft. of helium and require virtually no ground equipment except perhaps a mast at frequent stopping points. Ordinarily, the dirigible would hover nearly motionless while the cargo and harness were quickly unhooked.

Slate says the prototype airship would cost about $15 million, while the second would cost about $8 million and subsequent models $6 million. At these rates, the company says, the first ship would pay for itself in about three years while operating constantly at a cost of 17.5 cents per ton-mile. Following ships would carry cargo at 10 cents per ton-mile.

• **New capability?**—Commenting on the Slate proposal, Maj. Gen. W. B. Keese, then AFSC deputy chief of staff for plans, said in his proposal to AF headquarters:

"The problem of moving the *Saturn*-type booster introduced the possibility that the development of an airship might be justified, not on a cost/effectiveness basis, but on the basis of being able to do something which could not be done in aircraft. An airship would provide considerable flexibility in the movement of outsize objects. In addition it would permit maximum freedom of choice of manufacturers of large boosters, i.e., the Air Force would not become captive to manufacturers who have built plants in the vicinity of launch sites or adjacent to water transportation. In spite of the added capability and flexibility of the airship, it has been difficult to contemplate the initiation of an airship development in competition with high-priority military projects."

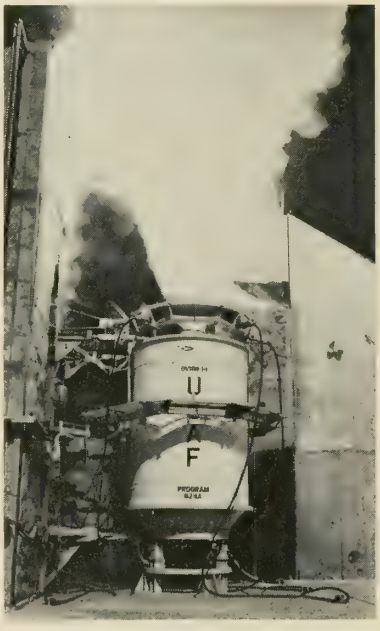
In commenting on his last point, however, Keese said the Slate Co. proposal is "one of the rare instances where American industry proposes to accept the burden of the risk of development. . . . This is a refreshing and highly commendable approach and should be evaluated, not only in terms of the specific proposal, but for possible application to other areas of interest."

The offer made to the Air Force by AMF's Government Products Group regarding the airship transport commended the approach to the problem and added that it seemed much more reasonable than the prospect of widening roads throughout the country.

AMF expressed interest in the project and volunteered assistance in its fulfillment.

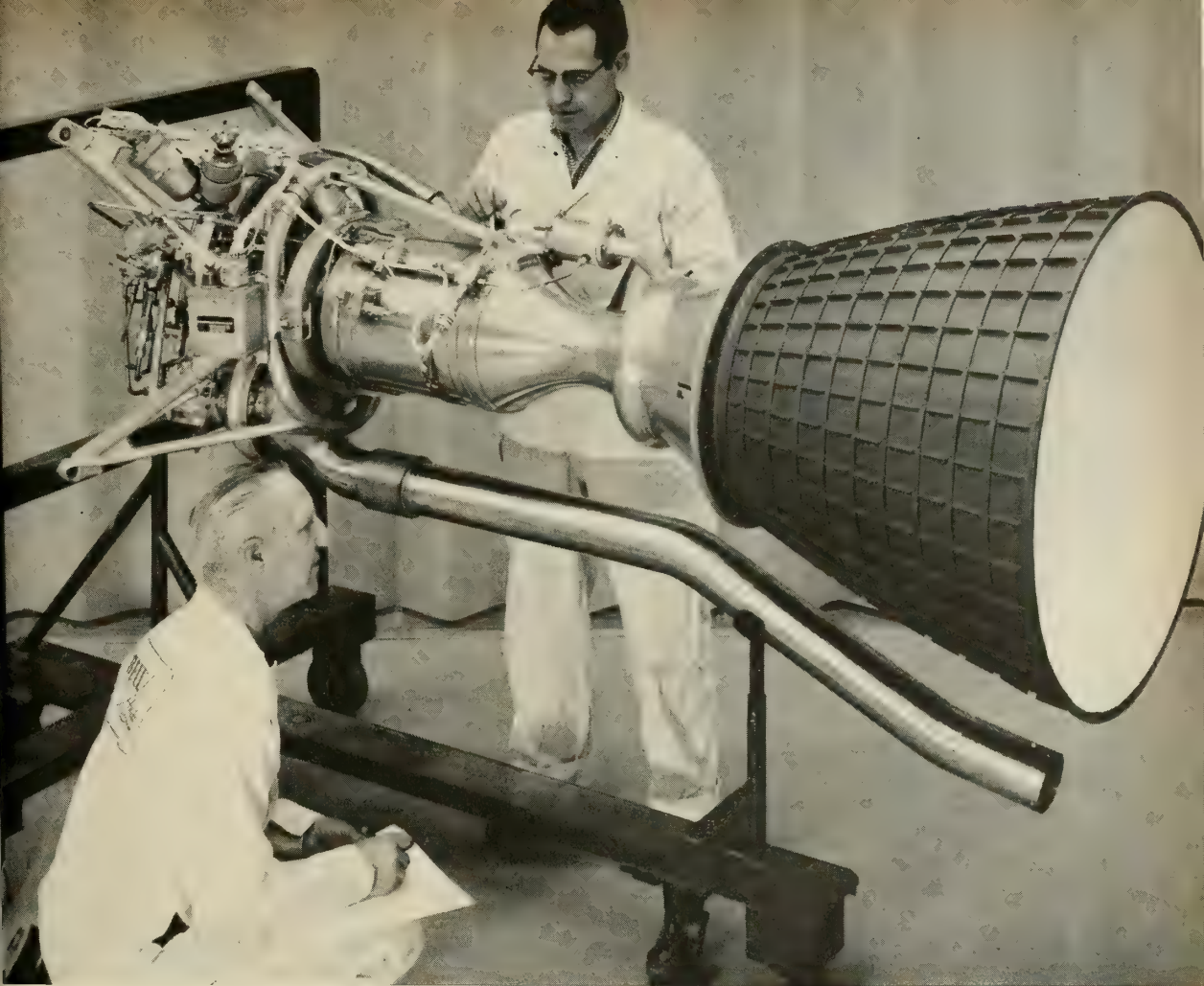
• **Early interest**—In considering the basic proposal, AF is using, among other things, pre-World War II reports advocating such a ship. The encouraging findings were returned by a committee consisting of W. F. Durand, A. V. DeForest, William Hovgaard, Frank B. Jewett, Theodore von Karman, Charles F. Kettering, R. A. Millikan and Stephen Timoshenko.

This committee's highly favorable report followed efforts at that time (1936) to evaluate the role of airships as heavy-cargo carriers and military craft. However, the war saw the airship used largely in an anti-submarine capacity. ■



Titan III-C Segment Fired

FIRST 120-in. segment firing under the Titan III-C program generated about 250,000 lbs. thrust during a test at United Technology Center Feb. 23. UTC, prime contractor for Titan III solid boosters, called the 120-sec. firing a complete success. Thrust vector control equipment was included in the test. Five of these single segments will be joined to form a single Titan III booster (M/R, Feb. 18, p. 36) capable of over 1 million lbs. thrust.



Bell Aerosystems' powerful Agena engine has an uncooled ceramic-coated titanium nozzle extension.

Titanium's compatibility with ceramics makes rugged, light-weight parts for ultra-high temperatures

One of the first practical examples of a unique partnership is now hard at work in space: the Agena's ceramic-coated titanium rocket nozzle extension.

Alone among structural materials, titanium has a coefficient of expansion (5.7×10^{-6} in./in./°F) close to vitreous materials. This useful compatibility opens up many possibilities for tough, strong parts that can be subjected to ultra-high temperatures. Where before only unsupported graphite and ceramics could withstand the searing blast of rocket gases, re-entry and the like, it is now possible to mate ceramics to titanium. Results...?

Take a look at the uncooled nozzle extension on the Agena. According to Bell Aerosystems Company, who designed and built the Agena engine, a base of titanium sheet coated with aluminum oxide was able to save 20 pounds over the original unsupported graphite part. Yet it was able to give equal heat resistance and at the same time provide a significant increase in strength and ability to withstand rough handling.

The uncooled titanium-ceramic nozzle extension has increased nozzle area more than 100% over the previous model, contributing to an improvement in specific impulse and superior performance. The restartable Agena engine has become the workhorse of the Air Force's Satellite Program, the Ranger, Mariner and other NASA programs.

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Technical Countdown

ELECTRONICS

CAL Shock Tunnel Reaches Mach 18

The 9½-ft. dia. test section of Cornell Aeronautical Laboratory's big wave superheater was tested successfully Feb. 8 and is now undergoing calibration runs. Mach 18 was attained at 3000°F at a simulated altitude of 250,000 ft. The 5-million tunnel uses a rotating drum containing 288 shock tubes. It is capable of up to 15-sec. sustained operation. Funded by DOD's Advanced Research Projects Agency, it will be used in Project Defender studies.

Beam-Plasma Tube Operates at 23 Gc

An experimental electron tube that uses the interaction of a pulsating electron beam and ionized cesium gas has been used successfully to amplify radio signals near the millimeter-wave region. Developed by RCA for the Air Force Aeronautical Systems Div., the device could lead to new communications and radar frequencies in the infrared region. Tests to date have indicated a maximum gain at 23 gc of 40 db with a net gain of 8 db. Power gain, RCA claims, is 13 db/cm.

High-Gain Laser Tested

Bell Telephone Labs reports successful operation of the first high-gain gas laser. Employing a helium-neon gas discharge at a 3.39-micron wavelength, the device has achieved gains of up to 50 db/meter, or high enough to serve as a practical amplifier. A 300-mc bandwidth has been shown about each of several lines near 3.39 microns. This bandwidth could be increased by a factor of 10, BTL claims.

1200-ft. Tower to Support L-F Studies

As a part of its continuing low-frequency communications test program, the Electronic Systems Division of the Air Force Systems Command is having a 1200-ft. radio tower built near Barstow, Calif. Due for completion late this May, the $600,000 structure is being erected by Dresser-Ideco Corp. Electronic equipment to be used in test transmissions will be supplied by Space-General Corp.

Laser Communications One Step Closer

A prototype communications system, developed by General Telephone & Electronics Corp. is believed to be the first to successfully transmit and receive television information using a laser beam to carry the signal. The receiver uses the traveling-wave-tube photo detector developed jointly last year by Stanford Univ. and Sylvania. The demonstration unit is a laboratory model.

SPACE MEDICINE

Frozen Astronauts Forthcoming?

Russian scientists are discussing the possibility of "freezing" astronauts for long space trips since successfully reviving two lizards after 5000-year hibernations. A four-toe triton, found 25 ft. beneath the Siberian tundra, revived after being kept at room temperature for some time and lived approximately three weeks. A second lizard of the same species found 13 ft. underground in the far north came to and lived practically a full summer. Both lizards were unafraid of people and readily ate flies and berries. Studies of the hibernation sites resulted in the 5000-year figure, and the scientists concluded it might be possible to induce suspended animation in present-day vertebrates, including man.

Rocket Fuel Antidotes Needed

While toxic properties of rocket fuels may be well known, little has been done about developing antidotes for them. If a major accident occurred, the demands on clinical medicine would be horrendous, an Air Force doctor has said. *Titan II*, says Maj. Johnie Reeves, may be a veritable Pandora's box in this respect.

Van Allen Belt Clean-up Postulated

Most of the artificial radiation belt and a good bit of the inner radiation zone of the Earth could be swept clean by a space "broom," STL physicist Alan Rosen says. A plane absorber of area 1 km² could be used, coplaner with the equatorial plane, and moving radially in the equatorial plane between altitudes 100 km and 5100 km and encountering all particles crossing it. Even at 1/10 efficiency, Rosen said, the inner radiation zone could be emptied in a year.

PROPULSION

Zero-Launch Rocket Contract Awarded

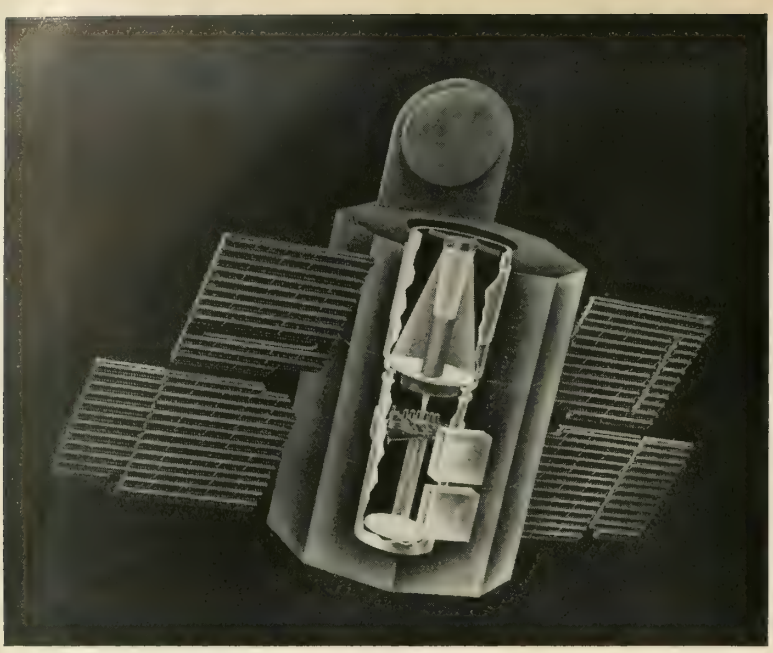
Rocketdyne's Solid Rocket Div., McGregor, Tex. will develop a booster for the zero-length launching of the F-104 fighter-bomber under a $2 million contract from Lockheed Aircraft Corp. An improved nitrate propellant and lightweight case will be involved in the program, which developed from West German Air Force requirements for F-104 advanced combat area take-offs.

Solid Rocket Sealing Studied In New Chamber

Atlantic Research Corp. is operating a space-simulation facility capable of subjecting samples to 7.8×10^{-8} mm Hg, space radiation to 10,000 Rads/hr., and thermal cycling between —200° and 250°F. The system has sufficient vacuum capacity to handle a planned 7 by 10-ft. chamber, but the current work space is only 3 ft. in diameter. ARC is evaluating sealing techniques for protecting solid rocket motors exposed to the space environment for extended time periods. The NASA-sponsored seals study will end this month.

N_2O_4 Plant to be Built

Hercules Powder Co. will build a new nitrogen tetroxide plant at its Hercules, Calif. plant. The processing unit will be a duplicate of an existing tetroxide facility in operation since early 1959. Completion of the new unit is expected before the end of 1963, and Hercules spokesmen are confident of handling any anticipated demand with the expanded plant. The firm is a major supplier of red fuming nitric acid to both military and space programs.



GEP To Alte

Goddard SFC's big telesco should solve mysteries of t far ultraviolet; mirrors ma of beryllium represent maj breakthrough in engineeri

by William Beller

THE WORLD'S LARGEST "eye in the sky" is slated to look through the biggest window ever opened into the heavens two years from now when a 38-in. telescope rides into space on the second *Orbiting Astronomical Observatory*.

Known as the Goddard Experiment Package (GEP), the telescope and its optical system will probe the stars for spectral data in the virtually unexplored ultraviolet range from 4000 Angstroms to 1000 Angstroms.

"There's not a major astronomical question the GEP could not supply significant answers to," James E. Milligan, astronomer at NASA's Goddard Space Flight Center, told MISSILES AND ROCKETS. He indicated it could cause a revolution in astronomy as profound as that created by Galileo's scientific use of the telescope.

GEP will be as much a national facility as the Mt. Palomar telescope, Milligan asserted. "It will be a piece of equipment of universal usage and with many different modes of operation," he said.

Milligan and fellow Goddard astronomer Theodore P. Stecher created a furor last year when they pointed out that the hotter stars aren't putting out as much energy in the far ultraviolet as they should according to theory, and are at least an order of magnitude deficient. But "nobody yet has an adequate theory why," said Milligan. He added that GEP could point the way to an answer.

• **$200 million for OAO's**—It's estimated that nearly $200 million will be spent to develop, build, instrument and extract data from the first three *OAO's*. Later models are expected to cost much less.

At present, however, only two *OAO's* are under contract. Smithsonian Astrophysical Observatory and the University of Wisconsin have one experiment each on the first; Goddard has the experiment on the second; and Princeton University is scheduled to have the experiment on the third *OAO*—when the spacecraft contract is signed.

The relatively high initial price NASA is willing to pay to build astronomical observatories shows how very important the space agency feels they are in furthering the nation's space science program.

The next logical step in space astronomy is to devise a 100-in.-aperture telescope. Although the cost undoubtedly would be enormous, reputable astronomers have seriously advised NASA to consider the effort. This was revealed in the 1962 report of the Space Science Board of the National Academy of Science.

• **Who's in charge**—Grumman Aircraft Engineering Corp. is developing *OAO* spacecraft under contract with NASA. Goddard Space Flight Center is supervising this work as well as that of Kollsman Instrument Co.—prime contractor for the $3.3-million experiment package.

Among the first-tier subcontractors: Bausch and Lomb, Rochester, N.Y., rules the diffraction grating; Diffraction Ltd., Bedford, Mass. polishes and figures the mirrors; Pioneer Astrometalics Corp., Chicago, machines the mirrors; and the Institute of Optics, University of Rochester, Rochester, N.Y., devised the optical design.

• **To process 14,000 stars**—Through rocket flights, astronomers have obtained spectra below 3000 Angstroms for only seven stars. Up to now, these data comprise the free world's total stellar knowledge of spectra in the far ultraviolet. Balloon flights haven't contributed any such data because the ultraviolet is cut off at about 100 miles altitude—higher than aerostats can venture.

The rocket data have very low resolution—50 Angstroms. Ground data resolution, however, is quite high, and ground stations can get almost all the stellar information they want in the region above 3000 Angstroms.

The Goddard package will be able to obtain spectra of about 14,000 stars a year in the far ultraviolet, said Milligan. He bases his figures on an average of 10 minutes per star to get a spectrum —plus a large safety factor.

On a first-time-around, practical basis, the spectrum resolution sought for GEP is two Angstroms. Milligan pointed out, however, that the system can be upgraded to resolutions of 0.05 or 0.04 Angstroms.

GEP is designed to point at a star with an accuracy of one second of arc. In other words, the system will be able to supply an error signal of one second of arc to the *OAO* orienting mechanism.

A GEP prototype will be ready for testing next year, according to Edward Chin, Goddard project manager. The following year the flight model is scheduled to go into orbit.

GEP is 113 in. long by 40 in. in diameter. It will weigh 1000 lbs. with

ll Astronomy

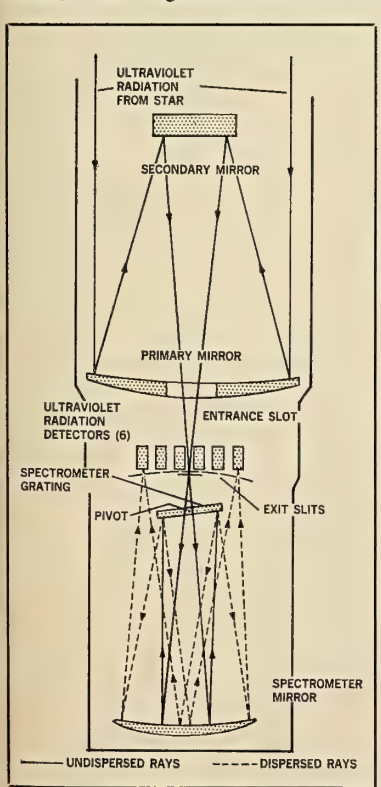
ballast, 700 lbs. without. Only 30 watts will be needed to run it.

• **Beryllium mirrors used**—Many of the GEP subsystems are in breadboard. In addition, the mirrors for the optical system are machined and ready for coating.

The primary and spectrometer mirrors are said to be the most critical parts of the system design. Made of beryllium—an achievement in itself—they cut system weight considerably and lend thermal stability.

"We didn't know how these mirrors would behave until we made up some samples," said Chin. "They work fine—that's why we can talk about the system now."

"Without these mirrors," Chin added, "there might not be a GEP."



LIGHT-RAY paths in GEP optical system.

The mirrors are lighter and stiffer than quartz—the usual mirror material for ultraviolet work—and have better thermal characteristics. In the manufacturing process, the beryllium mirrors are first rough-machined, then stress-relieved and finished-machined. Next they are temperature-cycled and machined to ± 0.001-in. tolerance.

In the final phase, the mirrors are Kanigen-coated and polished for better ultraviolet reflectance down to 1000 Angstroms. Normal aluminum coating is not acceptable because it does not have sufficient reflectance in the far ultraviolet.

• **Tracing the rays**—The telescope and spectrometer will be the most accurate optical system ever flown, said Chin.

The concept of the system is straightforward: light from a star enters the telescope, goes to the 38-in. primary mirror and is reflected to the secondary mirror. Made of quartz, the secondary mirror converges the light onto the entrance slot leading to the spectrometer mirror. In turn, the spectrometer mirror directs the light to the spectrometer grating.

The grating is a ruled square, 8 in. by 8 in., and will be the largest grating yet flown. It is also made of beryllium, in contrast with the usual boro-silicate crown glass.

The grating disperses the light and sends it back to the spectrometer mirror. Here it is redirected through a series of openings in the grating and then through the two-Angstrom slits in front of the six photon-scintillation detectors.

The detectors, in turn, generate pulses at a rate proportional to the radiation intensities they receive.

The spectrometer grating is asynchronously rotated in order to illuminate the detectors by different portions of the spectrum. In this manner the ultraviolet spectrum from 4000 Angstroms to 1000 can be covered with the moderate resolution required.

• **Processing signals**—Pulse outputs of each of the six detectors are accumulated in six identical data-accumulator channels, said David S. Kushner, engineer at Kollsman Instrument. Each channel is described as containing two counters, one actuated by pulses from the detector, the other by timing pulses (at a 1.6-kc rate) from the spacecraft clock.

Both counters are allowed to accumulate pulses until the detector pulse-counter has filled to capacity (4096 counts), said Kushner. "The count accumulated in the clock counter during this interval is a measure of the time required to accumulate this fixed number of detector pulses. It is, therefore, a measure of average detector pulse rate, and consequently, a measure of the intensity of the radiation at that portion of the spectrum being examined by the detector."

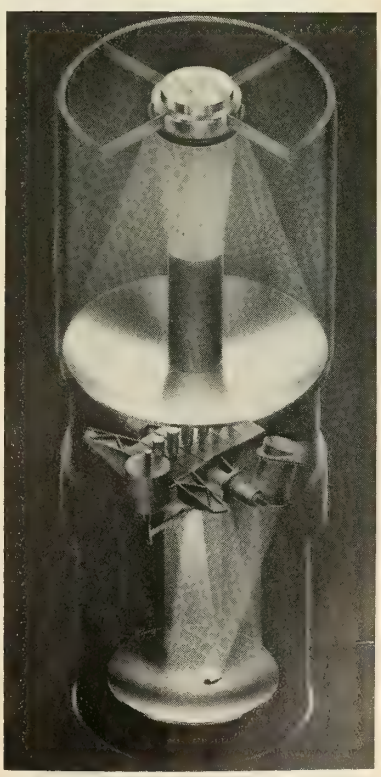
The experimental data are passed into the spacecraft memory. Then the *OAO* is interrogated as it passes over appropriate ground stations.

• **Fine-guidance system**—To help get the pointing accuracy needed, a fine-guidance pick-off mirror is installed on the spectrometer mirror. This smaller mirror directs about 10% of GEP's light onto a secondary mirror in the fine-guidance optical system. This system is, in effect, a small telescope with a field of view of ± 2.25 minutes.

Errors are developed in the system as a function of star position in the field. These error signals are passed to the spacecraft's stabilization and control system for orientation corrections.

If GEP were built by conventional methods of telescope construction, it would weigh at least two-and-a-half to three times more, Chin told M/R. By using an aircraft approach to the structural design, engineers have been able to cut GEP's weight significantly while increasing its thermal stability.

All structure will be aluminum and titanium, so that the assembly can operate satisfactorily within the temperature range 0°C ± 10°C. GEP is designed to be athermal, a necessary condition for a properly functioning telescope. ■



ARTIST'S concept of GEP ray patterns.

Hydrogen Reduction Method Praised

Ehricke reports GD group found this technique best for producing oxygen for long-range trips—except where long delays occur

by Heather M. David

HYDROGEN REDUCTION systems are the best bet for producing oxygen for long-range space travel, says General Dynamics engineer Krafft Ehricke.

Barring a serious emergency causing a long delay in return to Earth, a system of oxygen regeneration by hydrogen reduction of carbon dioxide stacks up against photosynthetic and other "mechanical" systems like this:

—*Weight:* Hydrogen reduction system would weigh about 75-100 lbs. per man; algae—765 lbs.; lithium hydroxide and electrolysis—275 lbs.

—*Volume:* Hydrogen reduction would require 1.3 cu. ft. of volume per person; a plant system—6-9 cu. ft.; LiOH—0.7 cu. ft.

—*Power:* Photosynthesis requires the highest power outlay; the others are relatively low. Even if solar light can be used, the variation of solar light during the journey will require control mechanisms, and solar orientation of the capsule.

Hydrogen reduction has added advantages of simplicity and fewer toxic byproducts, Ehricke said. The only feature that might be termed negative is the necessity of a high temperature—about 1350° F. He said the General Dynamics Life Systems Group has been working on a NASA project to compare the engineering feasibilities of several types of systems.

• **Algal systems**—However, the noted engineer pointed out, if some emergency occurred during an interplanetary flight and the crew was forced to wait for another return launch window—perhaps a year later—a photosynthetic system might be best. This would provide the crew with a continuing source of both food and oxygen.

The pay-off point in favor of an algal or duckweed system, according to other members of a recent AF-sponsored panel, might be on a permanent lunar colony.

Ehricke outlined a number of still-unanswered questions about algae:

—What do bacteria do to the system? What does the carbon monoxide produced do, and can it be controlled?

—What are the effects of zero-g, decompression, and other factors of the space environment? (A School of Aerospace Medicine doctor pointed out that although algae have survived short-term radiation exposures, no long-term, low-level radiation exposure has been possible because such an experiment would tie up a facility for too long a time.)

—To what degree will the algae utilize human wastes? Although current data seem to show they are utilized, will processing be needed for a long-term operation?

—Will algal or duckweed food be nutritionally sufficient on a long-term basis? What about pathological effects?

Ehricke also noted that the best system is one in which failure can be predicted and rapidly corrected. Little is known about algae on this score.

A state-of-the-art survey by Dr. S. S. Wilks of SAM showed that significant work on algal systems is being done by the Electric Boat Division of General Dynamics Corp., by Martin-Denver, and by Boeing. Dr. Wilks pointed out that his own work with giant duckweed (*spirodela polyrhiza*) showed that it compared well with algae in photosynthetic efficiency, and in operational weight, power and mass requirements.

The growing of other animals on algae for human consumption was virtually ruled out; panel members pointed out that when another "parasite" is introduced into the system, it loses about 90% efficiency. They said it would be better to utilize the algae directly.

Any system chosen for interplanetary travel will have to be able to function independent of gravity, Ehricke said. Although rotation may be built into the spaceship, the system will have to operate at zero-g during the capture period.

Dr. John Foster of Battelle Memorial Institute described an electrolytic process for the recovery of oxygen which was initially developed at Battelle. He said that it fitted criteria of gravity independence, flexibility in operating capability, adaptability to different spaces, reliability and availability.

He said the best system was one in which hydrogen was used to reduce CO_2; then water could be electrolyzed with relative ease. He noted that there are three routes to water using carbon dioxide and hydrogen, two of which are competitive in terms of space use. He said a three-man unit weighing 190 lbs., which takes a 900 watt-power supply for 24 hours removal of carbon, is essentially on the shelf now.

• **Biologic systems**—"Activated sludge" systems which use microbes to attack waste, oxidize it and produce potable water have the advantage of being the only method which produces useful protein in the process, according to Dr. Hans G. Clamann, chief of the bioastronautics department of the School of Aerospace Medicine. Dr. D. D. Chapman, of the University of Washington, said that a microbe colony of mixed variety could easily handle human wastes, vomit, and culinary wastes on a space voyage.

About 100 grams of cells would take care of all the wastes of one man, he said. The organisms that have been used can adapt to almost any "food," including cellulose and detergents.

A fairly simple oxygen-sensing mechanism could be used to regulate the system to program feeding times. Such a system would need about 10 continuous watts of power per man in weightlessness to operate; a total system of 10 liters of water per man would probably suffice, he said.

The question of acceptability of recycled water will be no problem, the panel concluded, since space-crew members will have a higher motivation than do Earthbound test subjects. It reiterated that recycled water is virtually sterile, and viruses are removed by several factors in each process.

None of these systems will be necessary until long-term voyages are made, Ehricke observed. And even a long-term vehicle will include some short-term life support systems, such as in the abort system, landing system, and perhaps even in a re-entry module. Development of these short-term systems will be taken care of in the technology leading up to *Apollo*. ■



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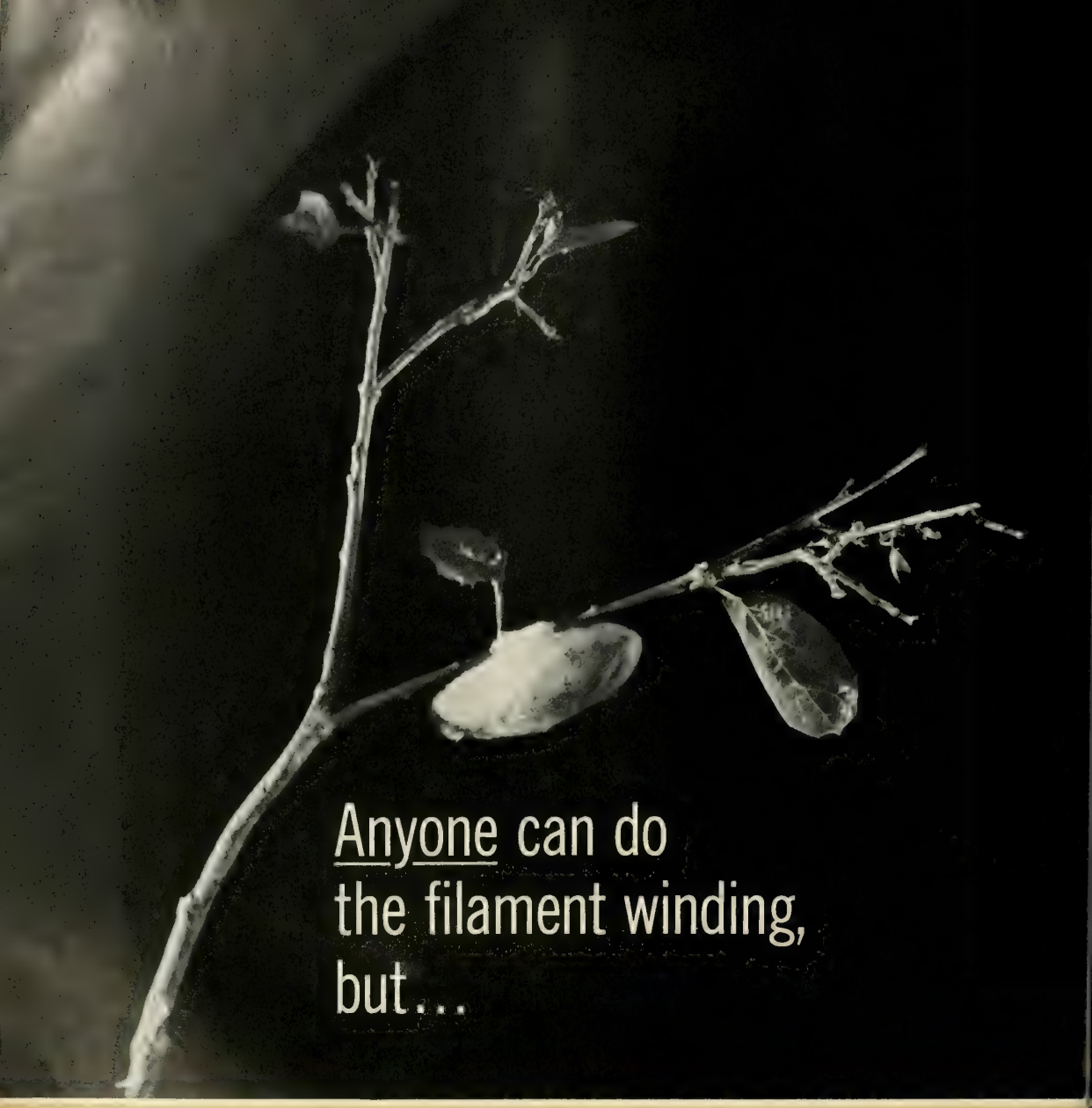
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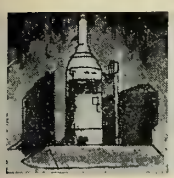
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Missiles

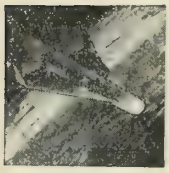
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; weight—500 lbs.; solid; HE depth charge; free-flight rocket; range 900 yds.	Operational; deployed on destroyers and cruisers
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid; nuclear or conventional warhead, range about 8 miles; weight: 1000 lbs.; unguided	Operational on destroyers, destroyer escorts, heavy cruisers, and guided missile frigates. Advanced ASROC being developed
ASTOR (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional; range, about 11 n. m.; solid	Development; to be deployed on hunter-killer submarines
★**ATLAS** (Air Force)	STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series inertial guidance; ATLAS "D" radio inertial	13 squadrons operational at 11 bases; Total No. of missiles: 129; phaseout to begin soon; ATLAS Standard Launch Vehicle to be developed for AF space programs
BOMARC IM-99A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000	Five bases operational in Northeastern U.S.; production completed
★**BOMARC** IM-99B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 n. m. range; nuclear	First base operational May, 1961; two more planned; production completed; first successful intercept of low-altitude aircraft completed Jan. 3
★**BULLPUP** GAM-83A, ASM-N-7A (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol/Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and one pre-packaged liquid motor; nuclear-tipped	Deployed with Atlantic and Pacific Fleets; operational with Air Force units; new training version under development, as TGAM-83 replacement
CORPORAL (Army)	Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion	Surface-to-surface; 75 n. m. range; liquid; nuclear; pre-set & command guidance	Deployed in Europe. SERGEANT to replace CORPORAL beginning in early 1963
★**DAVY CROCKETT** M-388 (Army)	In-house project directed by Army Weapons Command at Rock Island, Ill.	Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers: vehicle mounted or carried by two men	Operational in Europe; $13 million provided in FY '64 budget; 20 per division
ENTAC (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; solid; shaped charge HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
FABMDS (AADS-70) (Army)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles	Feasibility studies submitted to ARGMA in 1961; RFPs expected to go out this month for 60 day studies; program definition awards in May
FALCON GAR-1, 1D, 2, 2A, 3A, 4A, 9, 11 (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion; Lockheed Propulsion, GAR-9 propulsion	Air-to-air; 5 n. mi. range; supersonic; solid; conventional; 1, 1D and 3A, active radar homing guidance; 2, 2A and 4A, IR homing; GAR-11 model has nuclear warhead and hybrid IR radar homing	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under minimum effort development
GENIE MB-1 (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 6-mile range; nuclear; solid rocket; supersonic; proximity fuzing	Operational on F-101B & F-106; improved version under development
★**HAWK** (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; 100-38,000 ft. ceiling; launch wt., 1275 lbs.; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); bought by Sweden and Israel; advanced HAWK being funded at $25.9 million for R&D as antimissile weapon

★ Indicates changes since January 1963 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN M-50 (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5900 lbs.; ADVANCED HONEST JOHN also being developed	Operational; deployed in Europe; to be replaced by LANCE
★**HOUND DOG** GAM-77 (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 1.7; turbojet nuclear B version in production, ceiling in excess of 50,000 ft.	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
★**JUPITER** SM-78 (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear range; over 1500 mi.; guidance; all-inertial	Being withdrawn from operation; replaced by Polaris; future of missiles being studied
LACROSSE (Army)	Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion	Surface-to-surface; mobile; command guidance; 20-mile range; solid; nuclear	Operational; three units in Europe; eight activated; to be replaced by LANCE
★**LANCE** (Army) (Formerly designated MISSILE B)	Chance Vought Div., Ling-Temco-Vought, prime	A highly-mobile general-purpose missile; range 3-30 miles; Automet guidance; one missile per launcher; nuclear and conventional warhead; pre-packaged storable propellants	Large-scale development; eventually will replace HONEST JOHN and LACROSSE; division support weapon; to use multi-system test equipment
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable
M72 (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; range 500 yd.; earlier called LAW	Operational
★**MACE** TM-76 A&B (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid; nuclear; B model: 1200 mile range; inertial guidance	Two MACE-A and one MACE-B squadron deployed in West Germany; others on Okinawa in hard sites
MATADOR TM-61C (Air Force)	Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft.	Being turned over to West Germans; also deployed in Korea and on Taiwan
★**MAULER** (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; deHavilland, IR acquisition; Raytheon, radar; Burroughs, computer; FMC, vehicle	Surface-to-air; IR acquisition; solid; weight, 120 lbs.; highly mobile antiaircraft and antimissile missile; tracked vehicle; 12 per launcher	Development; NATO may buy; Navy planning SEA MAULER for landing craft; to use multi-system test equipment; FY '63 request is $83.3 million
★**MOBILE MEDIUM-RANGE BALLISTIC MISSILE** (Air Force)	Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos & Sperry Rand, re-entry system; Thiokol, propulsion; Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania, command and control; General Precision, guidance	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Continued development; no decision yet on production or deployment
★**MINUTEMAN** SM-80 (Air Force)	STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules third stage; Avco, re-entry vehicle	2nd generation ICBM; solid; deployed in hardened and dispersed silos; 32 sec. reaction time; nuclear; 3 stages; range: over 5000 miles; guidance, all-inertial; target selected in seconds; advanced MINUTEMAN with greater range-payload and new re-entry vehicle under development	Development; 20 missiles operational; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D., Grand Forks, N. D.; 950 missiles through FY '64, mobile version killed; advanced version to be fired from mobile command posts; expected operational 1965-66.
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; ceiling, 60,000 ft.; command guidance; Mach 2.5; solid and liquid; conventional	Deployed in U.S., Europe and Far East; 19 battalions still operated by National Guard are gradually being phased out
★**NIKE-HERCULES** (Army)	Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; ceiling, in excess of 150,000 ft.; solid; command guidance; Mach 3+; nuclear or conventional; antiaircraft, tactical missiles; weight, 10,000 lbs.	Over 80 batteries deployed in U.S.; over 10 N-H batteries deployed overseas. To be equipped with HIPAR, a high power acquisition radar, and anti-tactical-ballistic missile capabilities
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Antimissile missile; 3-stage; 200-mile range; solid; nuclear; command guidance; weight, 22,800 lbs.; length, 48 ft.; diameter, 36 in.; fin span, 10 ft.	Downgraded in favor of Nike-X; continued development planned; funded for $89 million in FY '64; three successful Atlas intercepts announced.
★**NIKE-X** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, Zeus propulsion; Douglas, Zeus airframe	Most advanced portion of NIKE-ZEUS concept; uses a mix of ZEUS/SPRINT missiles and Zeus multi-function array radar (ZMAR)	Engineering development; funded for $246 million on accelerated development schedule, but deployment still deferred; more effective than NIKE-ZEUS
★**PERSHING** (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; inertial guidance; approx. 400 n. mile range; nuclear; transported on FMC XM474 tracked vehicle	Flight test program nearing completion; to replace REDSTONE. W. Germany buying; be flight tested from Blanding, Utah, and Fort Wingate, N.M., to White Sands

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**PHOENIX** (Navy)	Hughes Aircraft Co.	Air-to-air missile for use with the TFX fighter aircraft	Development; HAC has $12.2-million contract
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT/Hughes, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training	Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 aboard first five submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 6-17; A-3 (2500 n.-mi.) aboard 18th and subsequent subs; all subs to get A-3 eventually; Total authorized POLARIS submarine program: 41	Nine subs each with 16 missiles operational A-2 scheduled to be operational in 1962; A-3 in 1964; nine A-3 flight tests have been conducted; two fully successful; deployed in Atlantic and soon Mediterranean; Pacific servicing facilities being built; British to buy missiles from U.S.
QUAIL GAM-72 (Air Force)	McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Thompson Ramo-Wooldridge, ECM equipment	ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
★**REDEYE** (Army)	GD/Pomona, prime; Philco, IR seeker; Atlantic Research, propulsion	Surface-to-air; 4-foot, 22-lb. bazooka-type; IR homing guidance; solid; conventional; length, 44 in.; diameter, 2.75 in.	Development; plans for full production stopped; no procurement funds in FY '64 budget due to development problems
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; inertial guidance; nuclear	Deployed in Europe; to be replaced by PERSHING
★**REGULUS I** SSM-N-8 (Navy)	Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear	Deployed aboard 2 cruisers; phaseout of 5 Regulus subs to start this year; KDU-1: drone version; missiles retrofitted with airborne guidance
★**SERGEANT** (Army)	Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; over 75 n. mi. range; nuclear; inertial guidance uses drag brakes; 10,000 lbs.	Production; major procurement to be completed during FY '63; will replace CORPORAL in Europe in early 1963
★**SHILLELAGH** (Army)	Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance	Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; testing under way at White Sands; To use multi-system test equipment; engineering development stage begins in FY '64
SHRIKE (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly ARM	Development; first production buy in FY '63
★**SIDEWINDER** (GAR-8) (Navy-Air Force)	GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; 1-C models: switchable IR and radar-guided warheads; improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version started in 1962; NATO-built version now under test
★**SLAM** (Air Force)	Ling-Temco-Vought, vehicles; Atomics International Div., NAA/Lawrence Radiation Labs, reactor; Marquardt, propulsion	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph	Propulsion system being developed under project PLUTO; feasibility proven by TORY reactor tests; DOD decision whether to continue program due this month
SPARROW III AAM-N-6A (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; production begun on advanced version (SPARROW III B) prime armament for F4H-1 and F3H-2 interceptor; SPARROW III and III A in use; on Aug. 7, SPARROW III intercepted REGULUS RDU-1 drone
★**SPRINT** (Army)	No contracts announced	High-acceleration missile for low-altitude interception of ballistic missiles; to be part of the missile mix in a NIKE-X battery	Development; studies submitted by Douglas, Martin and North American
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack sub Thresher; reportedly entire system was tested in recent nuclear tests
SS-10 (Army)	Nord Aviation, prime; GE, U. S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC
SS-11 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units and Army helicopters
★**TALOS** (Navy)	Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance	Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance	Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, nuclear-powered cruiser, has advanced TALOS
★**TARTAR** (Navy)	Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Ship-to-air; 10-mile range; Mach 2; beam-riding guidance; solid dual-thrust motor; conventional	Operational; installed aboard 15 guided missile cruisers and cruisers equipped with TALOS; advanced version available in 1962
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
★**TERRIER/ADVANCED TERRIER** (Navy)	Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; ABL, propulsion	Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional; 2 advanced versions operational	Operational aboard two attack carriers, 6 light cruisers, and 12 guided missile frigates

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR SM-75 (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear guidance, all inertial	Phaseout; 60 launchers closed by British; 15 missiles to be converted by Douglas for space boosters
★TITAN I (Air Force)	STL, systems engineering & technical direction; Martin, prime; Bell/Sperry, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	ICBM; 5000-mile range, LOX/RP-1 fueled; 90 ft. long; 2 stages	Operational; 54 missiles at 5 bases; first operational in April, 1962
★TITAN II (Air Force)	STL, system engineering and technical direction; Martin, prime; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle	ICBM; over 5000-mile range; N_2O_4 & Aerozine-50 storable fuels; 115 ft. long; 2 stages; bigger payload & longer range than TITAN I; basic core vehicle for TITAN III	Near operational; undergoing flight tests; some trouble experienced with second stage; to be used with Gemini program as booster; first out-of-silo launch attempt Feb. 16 partial success
TOW (Army)	Hughes, prime	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC
TYPHON (Navy)	Bendix, GD/Pomona, missile and missile electronics; Westinghouse, weapons direction system and radar; McDonnell, propulsion	Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets	Development; successor for TALOS, TARTAR and TERRIER. Norton Sound is being converted; system appears to lack DOD support
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	5-inch, air-to-surface; solid; unguided; 5 n.-mi. range; conventional	Operational; designed for use on jet fighter and attack aircraft



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★ANNA (NASA)	Bureau of Naval Weapons/Applied Physics Lab, prime; AF Cambridge Research Laboratories/Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter	Geodetic satellite; 600-mi. orbit; 36-in. aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by THOR-ABLE STAR	Development; first launch failed May 10; second launch successful in November; NASA assuming program responsibility; Navy will manage. Program now under NASA management. NASA to launch one satellite per year, beginning in 1964
★APOLLO (NASA)	North American, Command & Mission Modules, systems integration; Grumman Lunar Excursion Module (LEM); MIT, guidance development; tele-communications, Collins Radio; stabilization & control, Minneapolis-Honeywell; environmental control, AiResearch; parachute recovery, Radioplane; escape tower rocket; Lockheed Propulsion Co.; reaction controls, Marquardt; realtime computer complex, IBM; power conversion equipment, Westinghouse	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN and SATURN C-1B for earth orbits; Advanced SATURN (C-5) for lunar rendezvous; 3-modular spacecraft: command module, 5 tons; service module, 23 tons; lunar excursion vehicle, 15 tons; total weight: 85,000 lbs.	Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing 1967-68
ARENTS (ARPA)	GD/Astronautics, prime	Series of three satellites to investigate space environment of 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload; program re-evaluated due to CENTAUR delay
★AEROSPACE PLANE (AF-NASA)	No contracts announced	Manned, hypersonic spacecraft capable of earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, LH_2-LOX rocket	Joint NASA-AF research program approved. NASA funding $4 million in FY '64
BAMBI (ARPA)	Studies: GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost using space based platforms and interceptors	Feasibility still not proved; additional research under way
★BIOS (NASA)	No contractor announced	Recoverable capsules with primates aboard; capable of orbital flights up to two weeks; Flights to begin 1964	Originally joint AF-NASA program; however, DOD disapproved AF participation; NASA considering funding entire $76 million program in FY '64; AF to participate, but will not share funding. NASA has requested $24 million in FY '64 budget
COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	Multiple-launch, active repeater ComSat; 24-36 satellites in 5000-12,000 naut. mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster	One of two systems resulting from reoriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966; RFPs due this month

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE (AF-DCA-Army)	ITT, systems engineering & technical direction for DCA	24-hour, station-keeping, active repeater ComSat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA	Second system evolved from ADVENT; initial capability, 1964; operational, 1966
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR (X-20)** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link; Sunstrand, auxiliary power; Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear; Westinghouse, electric power system. Project ASSET, McDonnell	Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	Development; officially redesignated X-20, but either name may be used; program reoriented and suborbital flights eliminated, design details finalized during 1961; project ASSET will test structural integrity, using BLUE SCOUT; first DYNA-SOAR flight scheduled for 1965, but future still doubtful
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital	ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; first of two ballistic shots planned in 1962 from AMR was successful. ECHO II, late 1963
★**GEMINI** (NASA)	McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Westinghouse, rendezvous radar	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENA will be used for rendezvous missions. 15 spacecraft will be produced	Development; will be used to determine feasibility of rendezvous for lunar mission; first unmanned flight, 1963; manned and rendezvous flights, 1964-65; AF participation in program has been approved; this could add 4 to 6 more spacecraft to the program
★**LUNAR LOGISTICS VEHICLE** (NASA)	Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp.	Spacecraft to carry support payloads to the moon. Two designs under study, unmanned LEM vehicle and logistics spacecraft with 25,000 to 30,000 lb. payload	Program decision expected mid 1963; Cost expected to run to $500 million; contract expected in 1963
★**MANNED ORBITING SPACE STATION**	No contractors announced	Manned space station for testing components and techniques in the space environment. Design under study by NASA and AF	NASA and AF contending for program. Decision expected late 1963
★**MANNED SATELLITE INTERCEPTOR** (Air Force)	No contractors announced	Spacecraft capable of rendezvousing, inspecting and, if necessary, neutralizing hostile satellites	Not approved for development
★**MARINER** (NASA)	JPL, prime	450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B; 1000-lb. MARINER B also under development	Twelve shots planned. First scheduled Venus fly-by Aug. 1962 unsuccessful after booster failure; second passed within 21,594 mi. of Venus Dec. 14
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY will make one 34-hour flight this year to end MERCURY program
MIDAS, PROGRAM 239A (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads	Development; program being re-oriented from precise orbit satellite system to random orbit system due to technical difficulties with IR system; pushed back into development cycle
NIMBUS (NASA)	Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras	2nd generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for late 1963; second, six months later; four R&D satellites, four Weather Bureau satellites planned
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage	3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, SATURN C-1	First flight scheduled in 1964; two more in 1965
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in early 1964; 19 experiments planned for first shot; nine other shots planned—five in '64 and four in '65

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA and ATLAS-AGENA boosters, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; 10 more flights planned; advanced OSO studies by Ball Bros., Republic and STL
★PIONEER (NASA)	No contract announced	120-lb. spin-stabilized solar probe; Thor Delta launch vehicle	Bids requested by Ames Research Center. Contract expected before mid year; Launches to begin in 1965
★RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera takes pictures of lunar surface; ATLAS-AGENA B booster	R&D Ranger VI launch postponed; program undergoing management change; five more RANGERS added to program—making a total of 14; plans call for a total of 22
★REBOUND (NASA)	No contract announced	System of three rigidized multi-launched low-orbit passive communications satellites; ATLAS-AGENA booster	Under study
★RELAY (NASA)	STL, project coordination and systems planning; RCA, prime	150-lb., spin-stabilized, wide-band, 700-3000 mile orbit active repeater experimental communications satellite. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; two more in 1963; advanced RELAY under study
★SATELLITE INSPECTOR, PROGRAM 706 (Air Force)	RCA, prime; Hughes, detection equipment	Anti-satellite inspection system	R&D; formerly known as SAINT; re-oriented; 3 study contracts to be awarded to determine characteristics of a SAINT vehicle, probably based on a manned system using GEMINI capsule
★SAMOS (Air Force)	Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300 mile circular polar orbit	Development; scheduled to be operational late 1962; advanced SAMOS under development; FERRET version used for electronic intelligence and communications eavesdropping
★SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched in 1963 with Hughes and Lewis Center engines
SLOMAR (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Orbiting Development Station
★SURVEYOR (NASA)	Hughes, prime; Martin, SNAP device	750-lb. spacecraft for soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; Moon orbiting vehicle planned; SNAP nuclear generator optional	First Moon flights 1964 or early 1965; seven soft-landing vehicles planned; five lunar orbiters also scheduled
★SYNCOM (NASA)	Hughes, prime	24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in dia. and will weigh about 55-lbs.; capable of accommodating one full duplex radio telephone channel	First launch failed, Feb. 14, 1963 satellite believed to be in orbit but contact lost. Second launch, planned 2nd quarter, 1963. 500-lb. advanced SYNCOM to be developed
★SMS (Synchronous Meteorological Satellite) (NASA)	Republic, study contract	24-hour weather satellite, earth stabilized; TV cameras with variable focus; may use Snap-50 for power; Booster may be ATLAS-AGENA or CENTAUR	First flight 1966; No development funding in fiscal 64 budget
TELSTAR (AT&T-NASA)	BTL, management for AT&T	170-lb., active repeater, experimental industry communication satellite; DELTA booster	Development; first launch July 10 highly successful; second launch later this year
★TIROS (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (3,000 mi. apogee)	R&D; Six satellites launched; all successful. Seven more added to program (4 R&D NASA, 3 operational, Weather Bureau)
★TRANSIT (Navy)	Applied Physics Laboratory, prime; Martin SNAP device; Westinghouse, shipboard satellite signal receivers	Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; SCOUT booster	Operational system in process of being established for use by POLARIS subs; TRANSIT 5-A failed after achieving orbit in December
VELA-HOTEL (ARPA)	STL, prime; Los Alamos Scientific Lab/ Aerospace, payload	12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; three satellites placed in one orbital plane with three more in a plane 90° to the first; booster, ATLAS-AGENA	Initial launchings expected during this calendar year
★VOYAGER (NASA)	No contract announced	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface	Study contract to be awarded mid 1963. First launch, 1967

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics	Manned rocket plane; capable of 4000 mph flight at edge of space; each rocket engine develops 57,000 lbs. thrust; re-entry high angle of attack fights providing data for X-20	Powered flights in progress; unofficial records set: altitude (314,750 ft) and speed (4104 mph); X-15 will be used as trainer for X-20



Space Vehicles

AGENA (Air Force)	Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion	1700-pound upper stage; all-inertial guidance; re-start capability	Used in DISCOVERER, SAMOS and MIDAS programs; ATLAS, THOR boosters
BLUE SCOUT (Air Force)	Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	4-stage vehicle; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance	Operational; based on NASA's SCOUT; space probe and small (150-lb.) satellite launch vehicle; also AF's Hyper-Environmental Test System
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, ATLAS D booster, capable orbiting 8500 lbs.; 2300 lbs. to escape; 1300 lbs. on planetary flights	Development; program responsibility transferred from MSFC to Lewis; first flight test failed; late 1964 or early 1965 earliest possible operational date; next launch mid 1963
DELTA (NASA)	Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 430 lb. payload capability in 500 mile orbit; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively	Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational early 1963
★**LITTLE JOE II** (NASA)	General Dynamics/Convair, prime	Solid propelled vehicle with thrust of 800,000 lbs.; Launch vehicle for Apollo suborbital flights	First launch scheduled mid-1963; Four vehicles ordered thus far
★**NOVA** (NASA)	General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study. Further studies to be awarded	Capability of NOVA under study; no firm concept but should offer significant improvement over C-5 (20-30 million lbs. 1st stage thrust or use of nuclear upper stage)	Study to determine characteristics; operational target date post 1970 time period
★**ORION** (Air Force)	General Atomic	Space booster propelled by series of atomic explosions to lift 1000 tons into orbit	Studies; feasibility proven in Project PUT-PUT series; decision on continuing program pending
★**ROVER** (NASA) AEC)	Los Alamos Scientific Labs, ROVER Prime; Lockheed, RIFT vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion	First nuclear rocket: KIWI B-4A tests, prototype of NERVA engine, under way	First Rover flight test expected 1966-67; operational vehicle 1968-69
★**SATURN I** (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO. 1st stage: 8 Rocketdyne H-1 engines; 2nd stage: 6 Pratt & Whitney RL10-A3 engines; 22,000 lbs. into 345-mi. orbit	Three flight tests of 1st stage successful; all flights with inert upper stage; first flight with live upper stages 1963
SATURN I-B (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas	S-1: 8 H-1 engines; S-IVB: 1 J-2 engine; payload capability, 32,000 lbs. in 345-mi. orbit	Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; may also be used as a supply vehicle
SATURN V (Advanced Saturn) (NASA)	Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-1B: 5 F-1 engines; S-11: 5 J-2 engines; S-IVB: J-2 engine; 120-ton payload in 345-mile orbit; 43 tons to escape velocity; 30 tons for planetary missions	R&D; first flight scheduled for 1965; prime booster for APOLLO missions; will also be used to boost Orbiting Space Station
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150-lb. payload in 345-n.-mi. orbit	Operational payload being increased to 250 lbs.
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability about 900 lbs. in 300 mi. orbit; upper stage has restart engines	THOR-ABLE phased out. Used in TRANSIT, ANNA, and other satellite programs
★**TITAN III** (Air Force)	Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance	Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance	Development; first flight late '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned: 5 TITAN II core vehicles (A version), 12 full TITAN III's (C version); operational in 1965



Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years; orbits Earth; perigee 333 km, apogee 1680 km, period 105.1 min.; not transmitting

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits Earth; perigee 633 km, apogee 3957 km, period 133.8; transmitting 108.024 mc.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. In orbit around Sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth; perigee 563 km, apogee 3284 km, period 125.3; not transmitting

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle; apogee 1.142 au, perigee 0.9871 au; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 502 km, apogee 3733 km, period 129.7; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 545 km, apogee 1082 km, period 101.1; not transmitting.

★**PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 312 day period; aphelion 0.995 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; perigee 684 km, apogee 757 km, period 99.1; not transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 341 km, apogee 634 km, period 94.3. Not transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years Orbits Earth; perigee 445 km, apogee 530 km, period 94.2. Not transmitting.

★**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits Earth, perigee 612 km, apogee 1059 km, period 101.6. Not transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40-lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 610 km, apogee 1057 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 1208 km, apogee 1749 km, period 115.4.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 979 km, apogee 1200 km, period 106.9. Not transmitting.

★**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 409 km, apogee 2264 km, period 112.3. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 604 km, apogee 745 km, period 98.2. Not transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 472 km, apogee 542 km, period 94.8.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 634 km, apogee 2499 km, period 117.3.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Position uncertain.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 490 km, apogee 1782 km, period 107.9. Measures stellar gamma rays absorbed in Earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs.; GREB III, 55 lbs; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 882 km, apogee 996 km, period 103.8. GREB-INJUN—perigee 882 km, apogee 997 km, period 103.8. Transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: 136.5 GREB III and INJUN failed to separate.

★**TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 748 km, apogee 808 km, period 100.3.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits Earth, perigee 3299 km, apogee 3590 km, period 161.5.

EXPLORER XII (83 lbs.) U.S. Launched 8/16/61. Insufficient observations.

★**MIDAS IV** (3500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3482 km, apogee 3770 km, period 166.0.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee 963 km, apogee 1099 km, period 105.6. Damaged by radiation from U.S. July 9 nuclear test.

★**TRAAC** (240 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee 934 km, apogee 1129 km, period 105.6 Damaged by radiation from U.S. July 9 nuclear test.

★**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; lunar probe failed to impact, went into heliocentric orbit; aphelion 1.163 au, perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; apogee 839 km, perigee 714 km, period 100.3. Transmitting 136.23; 136.92 mc.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 499 km, apogee 641 km, period 95.9. Resumed transmitting on 136.744 mc. in latter part of June after stabilization lapse on May 22.

★**COSMOS II** (?) Russia. Launched 4/6/62. Orbits Earth; perigee 207 km, apogee 930 km, period 96.0. Transmission data not known.

★**ARIEL: INTERNATIONAL SATELLITE** (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 383 km, apogee 1205 km, period 100.7. Damaged by radiation from U.S. July 9 nuclear test. Transmitting 136.403 mc.

★**COSMOS V** (?) Russia. Launched 5/28/62. Orbits Earth; perigee 178 km, apogee 823 km, period 94.5. Transmitting.

★**TIROS V** (285 lbs.) Launched 6/19/62. Orbits Earth; perigee 587 km, apogee 976 km, period 100.5. Transmitting 136.235; 136.922 mc.

★**TELSTAR I** (170 lbs.) Launched 7/10/62. Orbits Earth; perigee 950 km, apogee 5638 km, period 157.7. Transmitting 136.05 mc.

★**COSMOS VIII** (?) Launched 8/18/62. Orbits Earth; perigee 240 km, apogee 479 km, period 91.7.

★**MARINER II** (447 lbs.) Launched 8/27/62. Heliocentric orbit on 348-day cycle. Planetary spacecraft came within 21,594 mi. of Venus Dec. 14. Perihelion 0.7046 au; aphelion 1.229 au.

★**TIROS VI** (281 lbs.) Launched 9/18/62. Orbits Earth; perigee 694 km, apogee 703 km, period 98.7. Transmitting 136.235; 136.922 mcs.

★**ALOUETTE** (300 lbs.) Launched 9/29/62. Orbits Earth; perigee 993 km, apogee 1040 km, period 105.5. Satellite built by Canada; launched by U.S. Transmitting 136.979 mcs.

★**EXPLORER XIV** (89 lbs.) Launched 10/2/62. Orbits Earth; perigee 817 km, apogee 97,972 km, period 2184.6. Transmitting 136.44 mcs.

EXPLORER XV (98 lbs.) Launched 10/27/62. Orbits Earth; perigee 321 km, apogee 17,603 km, period 314.9 min. Transmitting 136.101 mcs.

ANNA IB (350 lbs.) Launched 10/31/62. Orbits Earth; perigee 1072 km, apogee 1188 km, period 107.8. Transmitting 54; 162; 216 and 324 mcs.

MARS I (1965 lbs.) USSR. Launched 11/2/62. Expected to come within 621-6831 miles of Mars on June 25, 1963. Transmitting.

INJUN 3 (40 lbs.) Launched 12/13/62. Orbits Earth; perigee 235 km, apogee 2763 km, period 116.0.

RELAY I (172 lbs.) Launched 12/13/62. Orbits Earth; perigee 1322 km, apogee 7437 km, period 185. Transmitting 136.140; 136.620 mcs.

EXPLORER XVI (222 lbs.) Launched 12/16/62. Orbits Earth; perigee 756 km, apogee 1174 km, period 104.3. Transmitting 136.858 mcs.

TRANSIT 5A (135 lbs.) Launched 12/19/62. Orbits Earth; perigee 701 km, apogee 730 km, period 99.2.

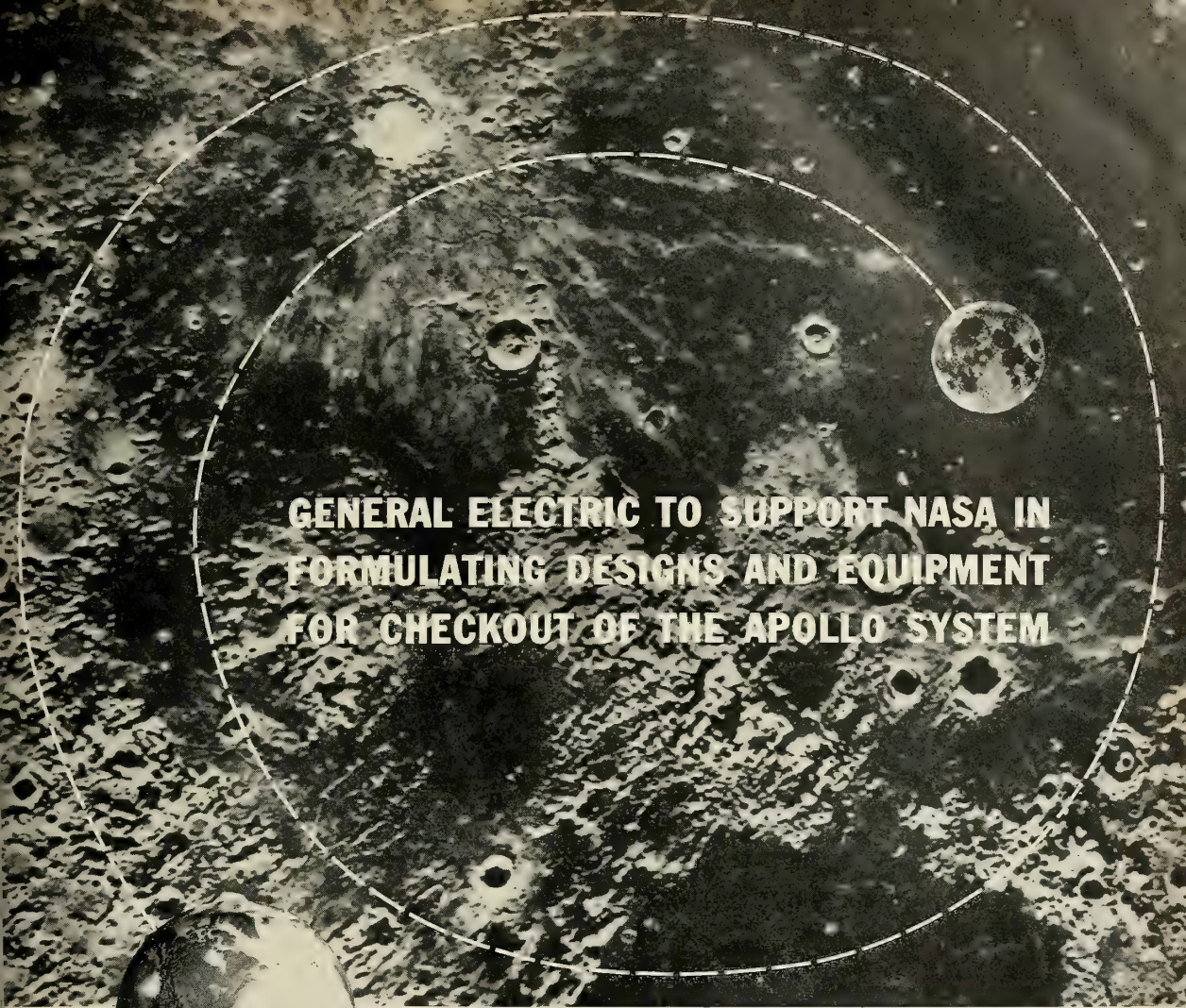
COSMOS XII (?) Launched 12/22/62. Orbits Earth; perigee 221 km, apogee 450 km; period 90.45. Transmitting 19995 mc.

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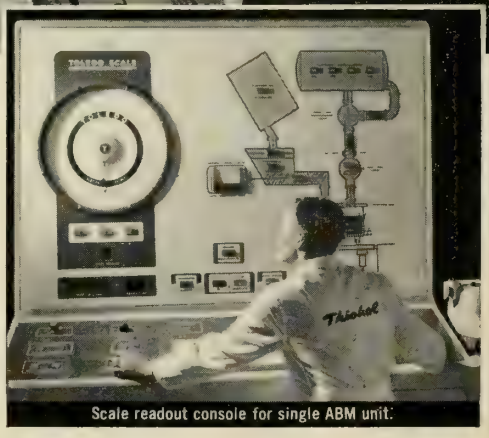


Thiokol's Automated Batch Mixing process has produced over 1 million pounds of very high energy propellant in less than a year.

With Air Force cooperation, Thiokol and Toledo Scales have developed an Automated Batch Mixing (ABM) system for propellant processing. In operation at Thiokol's Wasatch Division, ABM has turned out over 1 million pounds of high energy propellant. Recently completed Air Force Plant 78 is also fully equipped with this system, for production of Minuteman engines.

An electronically controlled method of materials handling, ABM eliminates the possibility of human error in the complex job of compounding and mixing propellant formulations. It also provides quality assurance throughout manufacturing on a recorded and "absolute" basis. Weighing precision is improved ten-fold. Over-all batch-to-batch variation is cut in half. Processing time decreases by 30%. Useable manufacturing capacity increases more than 20%.

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FEB Joining-Production Plan Evolving

Hamilton Standard works to improve reliability of interconnections, automate production

by Michael Getler

BROAD BROOK, CONN.—A major drive to solve reliability problems associated with interconnection and packaging of solid-state functional electronic blocks (FEB's)—and to effectively automate these processes on a production basis—is under way at the Hamilton Standard Div. of United Aircraft Corp. here.

The work is supported by HSD itself and by a $240,000 Air Force Aeronautical Systems Div. contract, under direction of the Electronics Branch of ASD's Manufacturing Technology Laboratory. It is part of a multi-pronged move by ASD into several problem areas associated with use of these devices. Many engineers believe FEB's ultimately will offer extremely high reliability (M/R, Oct. 29, p. 38). However, interconnection is one area where improvement is most needed in order to realize this potential.

HSD and others in the field say there are as yet no production techniques of proven reliability for interconnecting functional blocks into complete assemblies which will enhance the inherent volumetric efficiency of the semiconductor integrated-circuit concept.

Included in the first phase of the HSD program was an extensive survey and analysis of currently available FEB's and new development trends. Much of this data has been applied to definition of the preliminary modular interconnection and packaging scheme.

The study showed that though the majority of commercially available FEB's were for digital applications, there was a growing effort to develop the devices for analog use. Also, though most FEB's are now hermetically packaged in TO-5 or TO-18 cans, or in certain flat-form containers, engineers feel that use of a standard flat form package—spurred on by both AF and Navy emphasis—will probably prevail over other can geometries that may resist standardization and higher packing densities.

• **Several types handled**—The HSD system is aimed at ultimate operation with uncased FEB's. Design is expected to be flexible enough, however, to permit automated operation with presently available cased FEB's of different types and also with auxiliary thin-film passive elements.

HSD reports a prototype interconnection matrix-packaging structure which it has designed and developed appears both practical and suitable for production process. The system is compatible with both digital stack-type packaging and analog planar concepts. The firm is further refining production line design, and a final system concept is expected to be submitted in April for AF approval. Fabrication of pilot-plant equipment would begin one month after approval, pilot operation about 6 months after approval.

Ten demonstration subsystems of AF equipment will be selected for construction via the logical grouping of FEB and thin-film elements. Flight control and communications subsystem equipment will be included.

HSD is known to favor building, among other items, an engine-fuel-control system that uses analog components as representative of production-line capabilities. Use of analog devices is said to be more taxing at this point, and an engine subsystem would also demand operation in very-high-temperature environments (the HSD process is expected to yield packages thermally stable in 300°C storage environments).

The AF funding covers development of automated manufacturing processes and techniques for interconnection and packaging of FEB's, and establishment of an unbalanced (no capability for fabricating the basic FEB's) pilot line.

ASD project officers stress that the aim is to make considerable use of electron-beam equipment (it is estimated that at least 60% of the assembly operation may be handled with EB equipment), film deposition techniques, and automatic tape control.

In addition to its welding role, EB equipment will probably be used for etching the conductive paths which form the interconnection pattern along the horizontal wafer surfaces. Likewise said to be under consideration is use of EB to drill vertical interconnection holes through the wafers. Ultrasonic techniques are also under study for this application.

• **Adaptive beam operation**—The AF fiscal involvement in automated processing is supporting development of a modification to the EB welder which provides precise adaptive beam positioning control (APC) during critical weld operations between the FEB lead pins and the basic conductive substrate wafer (this is also called the carrier wafer since it is the top one of a multilayer package and the one which holds the FEB's). If effective, it is claimed, this device will provide a simple solution to one production step which has generally resisted automation in this application.

Engineers assert that inherent precision of this operation will allow automatic, pre-programmed assembly and fabrication of the package on a .025-in. grid matrix without increasing the manufacturer's tolerances on purchased FEB packages. In fact, they add, it may even serve to relax these tolerances below present levels.

Basically, the APC system is simple and said to be the most economical of several possible schemes to accomplish the same task. The basic electron beam is used as the search element in addition to its welding role. All FEB pins to be welded are coated with a fluorescent dye prior to loading. The beam scans the proper surface area until it activates the dye. A photoconductive cell is activated; scanning is stopped; a timing device is energized while the beam is automatically stepped to the approximate center of the lead; and a relay switches the beam from scan to weld. After the welding, the relay is de-energized; flip-flop circuits are reset to zero; and the worktable moves to the next welding station on the programmed grid matrix.

Feedback techniques used here are the only ones in the entire production system being developed. This, the firm says, is the key to mechanizing the entire FEB production line.

• **Production steps**—Refinements are still being made to the HSD laboratory procedures and materials, though portions of the basic packaging-production process are reasonably firm.

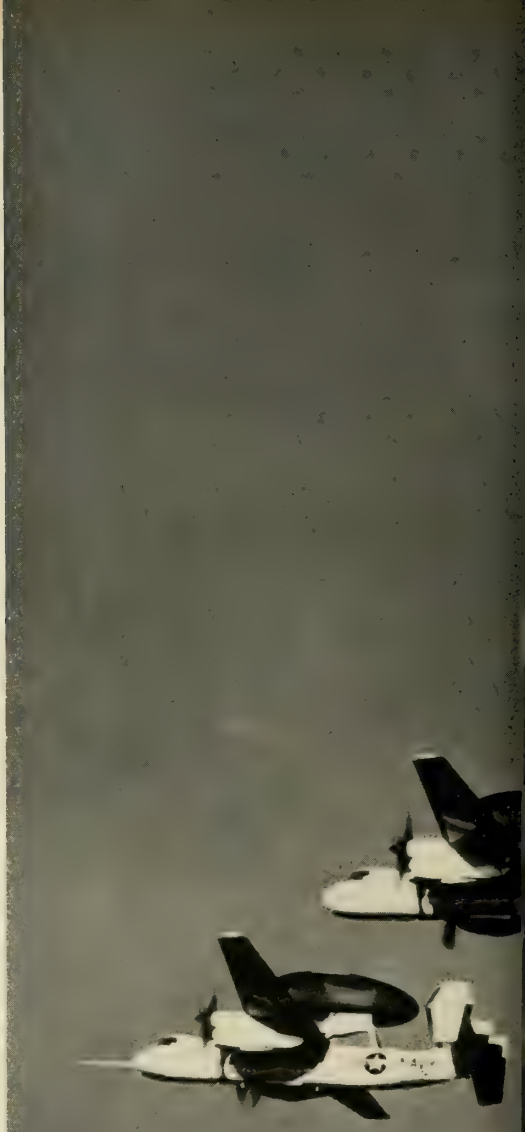
ASD officers emphasize that a number of small but important problems must still be solved, particularly in the choice of materials (other than the basic

(*Continued on page 40*)

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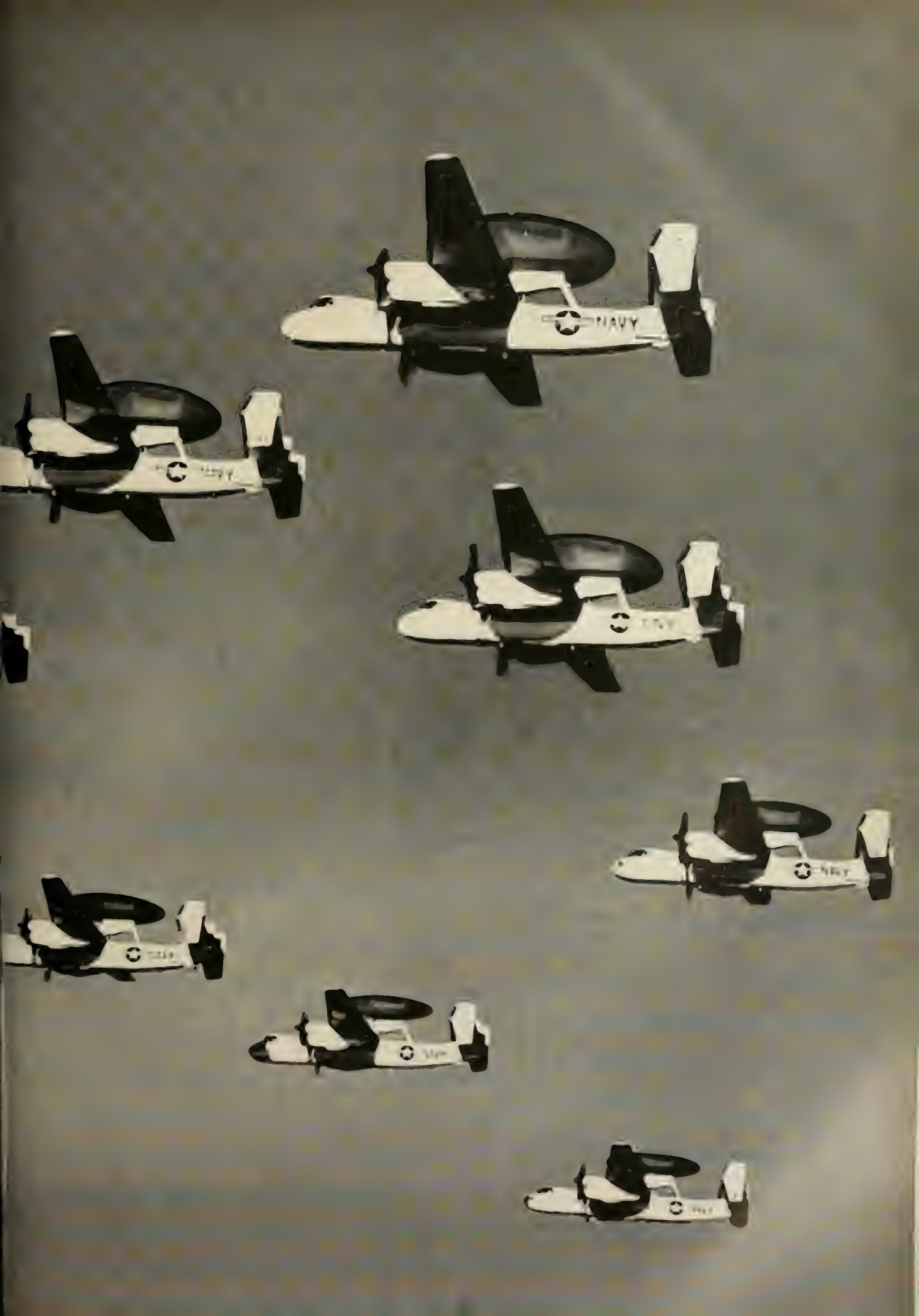


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FEB Plan Evolving

(Continued from page 37)

ceramic substrate). They expect certain evolutionary changes may occur in the system and techniques as it moves from the laboratory phase into a manufacturing project.

The basic unit of the interconnection matrix-packaging system is a multilayer, grooved, ceramic wafer to which the cased or uncased FEB's and thin-film elements are attached in a manner which HSD engineers claim optimizes heat dissipation to the package exterior. Both alumina and beryllia have been experimented with as substrate material; most development work has been carried out with alumina, however, because of beryllia's handling difficulties.

The actual FEB's and any auxiliary thin-film elements are placed in the parallel grooves which are formed in only the top, or carrier, wafer of the multilayer package.

Communication between various FEB's and passive elements is provided by a horizontal and vertical multilayer interconnection matrix which permits multiple crossover networks. At least 21 connector pins are provided on one edge of the basic top wafer for communication with external circuitry. Use of the adaptive beam techniques could lead to even more pins per wafer by allowing closer spacing.

In the HSD experimental design, to form the horizontal portion of the interconnection system, gas-plated or vacuum-deposited chromium may first be deposited over the individual wafers. Chromium, HSD reports, exhibits good capability to form a bond with the chosen substrate materials. Nickel could then be plated over the chromium to overcome electrical resistivity, increase thermal conductivity, and provide a surface to which lead and pin materials can be joined by either electron-beam or brazing techniques.

Crossover capability for the system is achieved by vertical feedthroughs joining the multilayer circuit boards. The vertical feedthrough holes actually are formed by joining the three layers, with the conductive path already formed by the earlier plating action on and through the drilled substrate surface.

The alloys used to provide the actual vertical interconnections also contribute to making the package hermetic. HSD reports that several methods are being evaluated; the one which may be best for production involves processing of alloy spheres which are placed in the vertical holes.

Prototype shallow cans have been designed for attachment to the periphery of the top wafer to provide hermetic sealing for the FEB packages. ■

Oakland Space Sessions Planned

More than 100 top authorities in industry, research, higher education and government will meet in Oakland, Calif., March 27-30, to discuss effective and practical applications of space research to solving the problems of expanding urban communities.

Entitled "The Space, Science and Urban Life Conference," the meeting is sponsored by the National Aeronautics and Space Administration and the Ford Foundation, in cooperation with the University of California. Dunsmuir House, an educational and research center, will be used for the sessions under the auspices of the City of Oakland.

The list of those invited to participate in the talks includes: C. M. Blair, VP, Space Communication, AT&T; Earl Johnson, president, General Dynamics; Dan Kimball, chairman of the board, Aerojet-General; D. L. Putt, president, United Technology Center; Charles Kimball, president, Midwest Research Institute; and A. C. Dickieson, director of *Telstar* for Bell Laboratories.

Among those named on the invitation as hosts were: Rep. George P. Miller (D-Calif.), chairman of the House Committee on Science and Astronautics; and NASA Administrator James Webb.

Industry Facilities

United Aircraft Corp. will build a multimillion-dollar addition to its Palm Beach County, Fla., Pratt and Whitney Florida Research and Development Center. The firm says this will give the center "the most advanced rocket engine liquid-propellant research capability in the United States."

When completed, the test facility will be able to handle safely all known combinations of liquid propellants, including such high-energy types as fluorine, hydrazine, diborane and hydrogen, a spokesman said. The addition will complement the existing cryogenic rocket engine test complex, which will continue to be used in development and testing of P&W's RL-10 liquid-hydrogen engine.

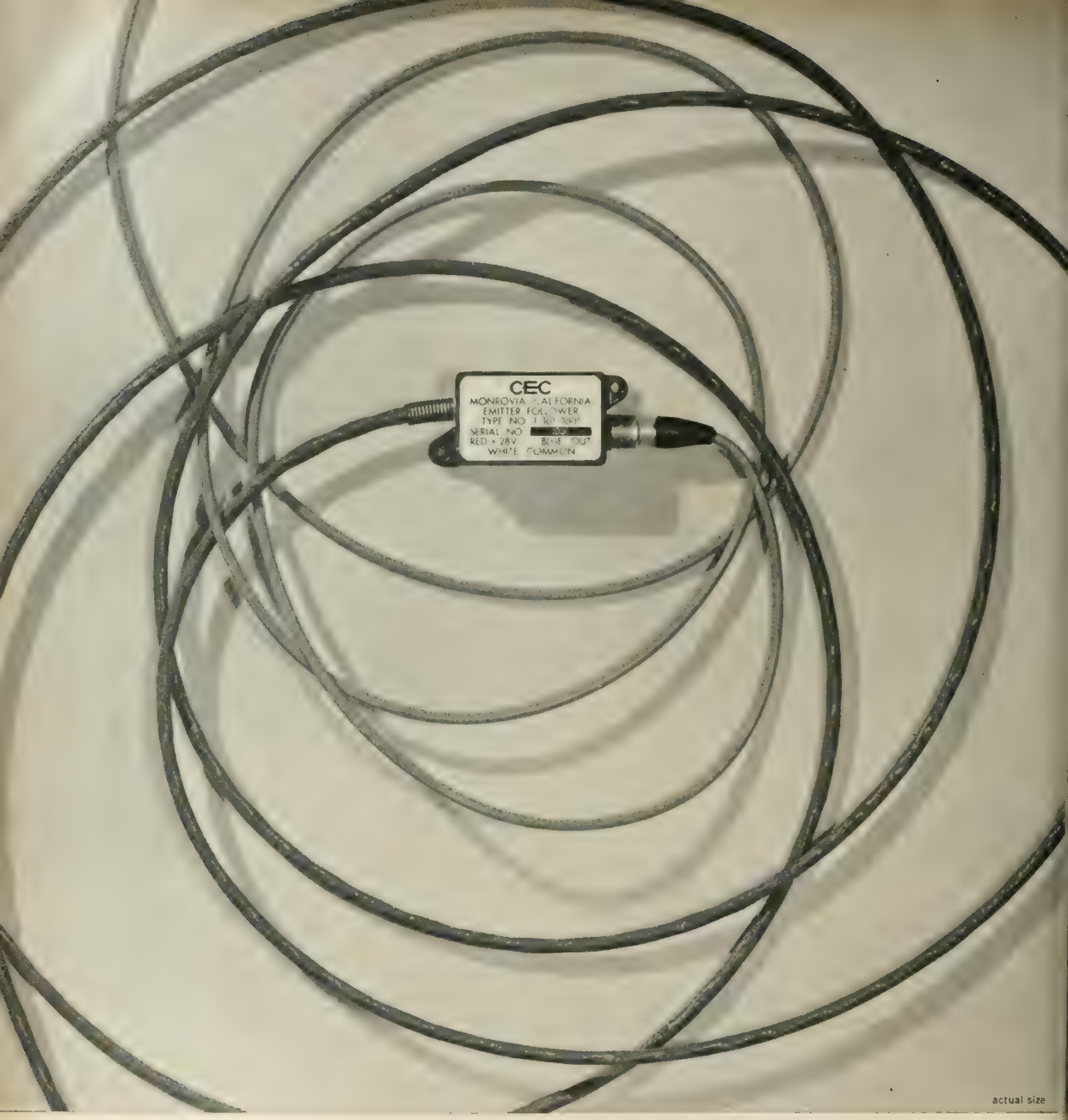
The expansion is expected to permit the firm to conduct basic combustion testing of many varieties and combinations of propellants up to 5000-psi pressures. It will be capable of testing thrust chambers with thrust ranges up to 50,000 lbs.

The six-year-old, 7000-acre center now has about one million square feet of floor space and employs nearly 6000 persons. . . . *Mueller Electric Co., Cleveland producer of electric clips and insulators, is undergoing its eighth major expansion. The added facilities will improve the firm's new-product production lines and increase storing areas for required inventories.* . . . The Laguna Indian Reservation, west of Albuquerque, N.M., is the site of a new electronic component manufacturing facility to be built by Burnell and Co. of Pelham, N. Y. The facility —to be built at a cost of $440,000 and designed according to specifications worked out with the Laguna Indian tribe—will more than triple the firm's manufacturing capacity. The 40,000-sq.-ft. plant is located on a 10-acre site and will employ at least 400 persons. Burnell manufactures filters, networks and related electronic components. Philleo Nash, Commissioner of Indian Affairs, worked with the firm in establishing the facility. . . . *Rubber Industries, Inc., developer of precision custom-molded rubber products, now occupies new, larger quarters at Shakopee, Minn. The firm is a subsidiary of Flo-Tronics, Inc., Minneapolis producer of electronic components and assemblies. Its line includes precision electronic connectors, seals and gaskets, and other molded parts for missile/space applications.* . . . Zero Manufacturing Co., manufacturer of systems and instruments packaging for electronics and missle/space applications, has established a new facility to produce structural sandwich materials. The facility, known as Zeroply, will be located in Zero's Monson, Mass., Eastern Div., and will occupy a 90,000-sq.-ft. building acquired last year from another firm. Maxwell Kantor, formerly with the Skydyne Corp., joins Zero as general manager of Zeroply. . . . *Globe-Union Inc.'s Centralab Div. will construct a new 40,000-sq.-ft. electronic parts manufacturing facility at Lafayette, Ind. Centralab makes ceramic capacitors, variable resistors, PEC integrated circuits and piezoceramic materials. The new plant, to be located at Purdue University's McClure Industrial Park, will cost $500,000 and is scheduled for opening in July. Centralab has other plants in Iowa, Ohio, Wisconsin, and Canada.* . . . Cornell Aeronautical Laboratory has allocated a total of $1.5 million for a variety of facilities expansion projects. The nonprofit lab's current property and facility holdings are worth about $15 million. Its annual research volume reached $16.8 million last year. The lab is an autonomous function of Cornell University. . . . *Space Technology Laboratories has optioned 17 acres near Huntsville, Ala. Land nearby was optioned earlier by Northrop Corp., Lockheed Missiles and Space Co., International Business Machines, and Brown Engineering. The land is owned by Research Sites Foundation, Inc., an affiliate of the University of Alabama and an active campaigner in missile/space real estate sales.*

Case Cases Industrial Reps

Sen. Clifford Case (R-N.J.) expects to propose legislation requiring industry representatives who maintain contacts with the Pentagon and other agencies to register as lobbyists.

"The enormous number of people." Case said, "that are constantly in the Pentagon from our great contractors—and all over Washington—now ought . . . to be registered as lobbyists. He added that "so long as the facts—their interests and what they are doing—are known," there is nothing wrong with lobbyists and lobbying.



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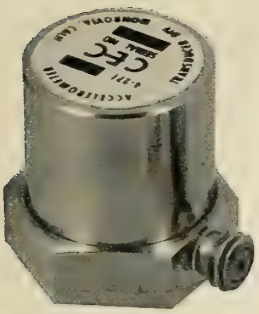


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contracts and procurements

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AIR FORCE

$50,158,000—**Martin Marietta Corp.,** Denver Colo., for design and building the *Titan III rocket* booster.

$29,000,000—**Radio Corp. of America,** New York City, for technical services in connection with the Air Defense Command's Ballistic Missile Early Warning System (BMEWS) facilities located at Thule, Greenland; Clear, Alaska; the Central Computer Display in Colorado; SAC Operations Display Facility, Offutt Air Force Base, Neb., and the Pentagon Display Facility, Washington, D. C.

$7,900,000—**General Dynamics Corp.,** San Diego, for work on *Atlas* missiles.

$7,885,000—**Hughes Aircraft Co.,** Culver City, Calif., for work on communications systems and missile guidance systems. Work to be done at Los Angeles.

$5,920,360—**Ryan Aeronautical Co.,** San Diego, for *Q-2C* aerial target drones.

$4,054,000—**Lockheed Aircraft Co.,** Sunnyvale, Calif., for work on space programs.

$3,502,000—**Ling-Temco-Vought, Inc.,** Dallas, for development study of low-altitude supersonic missiles.

$2,900,000—**Lockheed Aircraft Co.,** Burbank, Calif., for work on space programs.

$2,000,000—**Technical Measurement Corp.'s** subsidiary **Telemetrics, Inc.,** North Haven, Conn., for universal telemetry de-commutation systems.

$1,377,443—**Radio Corp. of America,** Camden, N. J., for a weapons control system.

$1,235,072—**Olson Construction Co.,** for missile test facilities at Green River, Utah.

$1,100,000—**Reflectone Electronics, Inc.,** Stamford, Conn., for updating ECM simulators.

General Precision, Inc., Little Falls, N. J., for a flight feasibility program in connection with *MMRBM* stellar inertial guidance which will utilize the *Polaris* missile (undisclosed amount)

ARMY

$95,000—**General Precision, Inc.'s Information Systems Group,** Glendale, Calif., for production of an auxiliary magnetic-tape memory system for the Army's Field Artillery Digital Automatic Computer (FADAC).

NAVY

$25,000,000—**Bendix Corp.'s Mishawaka Div.,** Mishawaka, Ind., for research and development of the medium-range *Typhon* missile system.

$6,147,861—**Raytheon Co.,** Lexington, Mass., for integrated *Polaris* missile sonar systems. Work to be done at North Dighton, Mass., and Portsmouth, R. I.

$4,332,000—**Minneapolis-Honeywell Regulator Co.,** Minnespolis, for *Polaris* missile guidance equipment.

$2,000,000—**General Electric Co.,** *Pittsfield,* Mass., for *Polaris* test guidance equipment.

$1,923,694—**Gilfillan Corp.,** Los Angeles, for automatic target equipment development.

$683,000—**United Aircraft Corp.'s Norden Div.,** Norwalk, Conn., for gas pressure systems used in *Advanced Terrier* and *Tartar* missiles.

NASA

$6,350,000—**General Dynamics/Convair,** San Diego, for design and manufacture of four *Little Joe II* launch vehicles and two launchers, and support at the White Sands Missile Range, N. M., where the first flight is scheduled for mid-1963.

$52,000—**Systems Engineering Laboratories, Inc.,** Fort Lauderdale, Fla., for a data-acquisition system for use in the *Saturn* missile testing program at Huntsville, Ala.

Geonautics, Inc., Washington, D. C., for a study to more accurately determine the geodetic location of stations in the two world-wide tracking networks—the Manned Flight Network and the Scientific Satellite Network.

INDUSTRY

$4,300,000—**Radiation, Inc.,** Melbourne, Fla., from **Collins Radio Co.,** for Pulse Code Modulation (PCM) telemetry systems and ground support equipment for the *Apollo* manned spacecraft.

$2,000,000—**Rocketdyne Div. of North American Aviation,** Canoga Park, Calif., from **Lockheed Aircraft Co.,** for development of a solid-propellant booster for West German F-104 fighter-bomber zero launches. Work to be done at McGregor, Tex.

$2,000,000—**H. I. Thompson Fiber Glass Co.,** Gardena, Calif., from **United Technology Corp.,** for 120-in.-dia. nozzles for first-stage booster motors of *Titan III-C*. Work to be done at Los Angeles.

$500,000—**International Telephone and Telegraph Corp.'s Industrial Products Div.,** San Fernando, Calif., from the **Martin Co.,** for components used in exploding bridgewire systems of the *Pershing* missile.

$200,000—**Garrett Corp.'s AiResearch Manufacturing Div.,** Los Angeles, from **Boeing Co.,** for design, development and manufacture of pressurization controls for the *X-20 (Dyna-Soar)* spacecraft.

REQUESTS FOR BIDS

GENERAL PROCUREMENT

Naval Shipyard
Bremerton, Wash.

Missile storage chocks, portable, aluminum, in accordance with Plan 706-57—112 each. Delivery Puget Sound Naval Shipyard. IFB 251-440-63B. Bid opening 3-19-63. Requests for bid sets must be received by 3-12-63. This is a reissue of item 10 in IFB 251-261-63.

Hawk Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Preparation on course documentation, materials, training aids, and conducting new equipment training course for *Hawk* system new equipment, high-power illuminator training. The first of eight courses will begin October 1963. Course locations are as follows: three in Germany, two in Korea, two in Okinawa, R. I., and one in the Canal Zone. Technical knowledge of the high-power illuminator required for preparation of course material, training aids and instructions precludes award to other than prime contractor—Raytheon Co. All inquiries relative to subcontracting must be referred to Raytheon Co., Lexington, Mass.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Vacuum-jacketed tank. Deliver to George C. Marshall Space Flight Center, NASA, Huntsville, Ala. IFB MSFC-63-235. Bid opening 3-15-63.

National Aeronautics and Space Administration
General Research Procurement Office
Houston 1, Tex.
Phone: WA 8-2811, Ext. 7351

(Continued on page 48)

Polaris: the first six years

It was January, 1957, that the U.S. Navy first announced its plans for a completely new kind of ballistic missile — and chose Lockheed Missiles & Space Company to build it. The six years since then have witnessed the swift evolution of Polaris from idea to mainstay of the nation's deterrent force.

Of equal significance is the revolutionary new method for speeding weapon systems to operational status that was born of the close-knit partnership between the Navy's Special Projects Office, Lockheed, and the entire contractor team. One requirement the new method took in stride was that the Polaris missile itself be



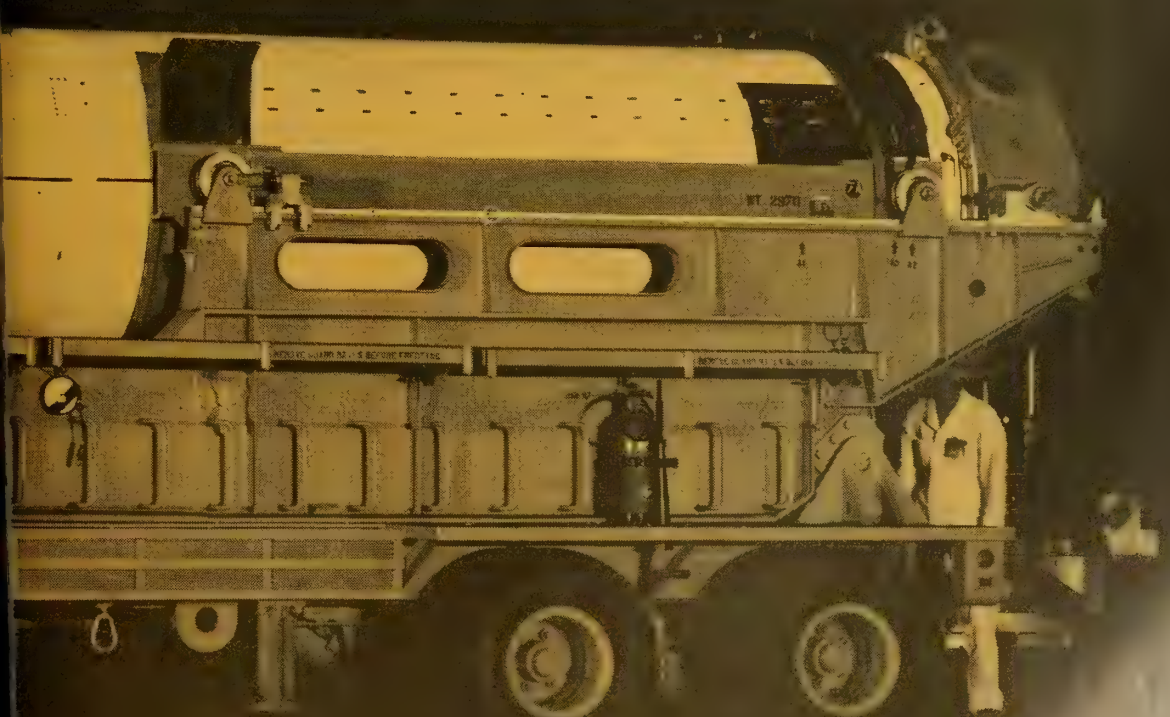
increased in both size and range as the program developed. When the first submarine armed with the 1200-mile A-1 Polaris went on patrol in November, 1960, the 1500-mile A-2 was already in advanced flight test. The A-2 has now been in production more than a year. The 2500-mile A-3 will join the fleet in mid-1964.

Polaris is a versatile missile. Compact, easy to transport, and extremely reliable, it can be launched from surface ships — or, by remote control, could be launched from the floor of the sea. Today the Navy-Lockheed team is prepared to meet whatever new challenges lie ahead for Polaris.

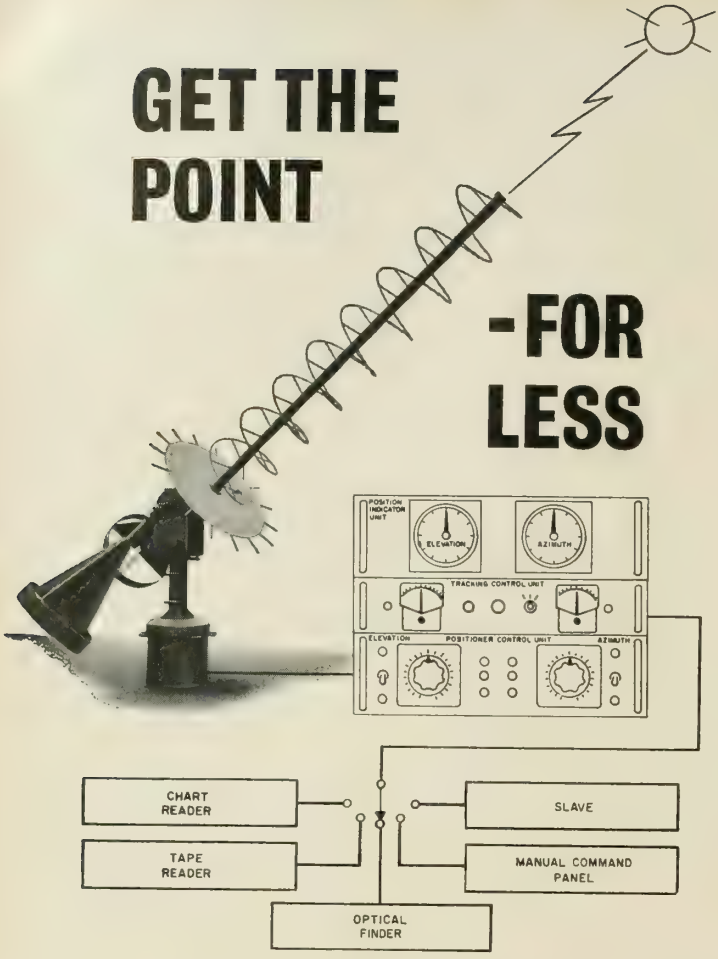
Lockheed

Lockheed Missiles & Space Company, Sunnyvale, California • A Group Division of Lockheed Aircraft Corporation

The A-3 Polaris, shown below on its transporter-erector at Cape Canaveral, is now in flight test.



GET THE POINT -FOR LESS



Scientific-Atlanta telemetry antenna position systems offer a unique, economical answer to the problem of following satellites, missiles, aircraft or astronomical targets with medium gain antennas. Such systems provide tracking rates of 6 degrees per second or higher and pointing errors of no more than 3 degrees. Yet, these systems are modestly priced at less than $10,000.

The two-axis antenna pedestals are "militarized" versions of standard Scientific-Atlanta antenna pattern range positioners, giving an extra margin of reliability even beyond the proven performance of these mounts. Control is provided by Scientific-Atlanta's augmented manual tracking equipment.

Features include two-axis tracking from programmed or slaved sources as well as manual control and continuous position indication; accessories such as optical finders, tape readers, chart readers, manual position command panel, and other input devices; use of solid state units for reliability and compactness (complete control/indication systems in 14" of rack space) and integration of standard Scientific-Atlanta instrumentation wherever possible throughout the system.

Rugged and reliable, these systems meet the environmental requirements of MIL-E-4158 and the RFI shielding requirement of MIL-I-26600.

We invite your request for more information. Please address Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta 24, Georgia. Phone: (404) 938-2930.

SCIENTIFIC-ATLANTA, INC.

Circle No. 7 on Subscriber Service Card

Contracts/Procurements

(Continued from page 45)

Manned spacecraft advanced analog television study for selection of a television bandwidth compression system utilizing the analog rather than the digital approach—1 study. Deliver to NASA, Manned Spacecraft Center, Houston 1, Tex. RFP MSC-63-452P. RFP due date 3-21-63. Bid sets available through 3-15-63 unless sooner exhausted.

An operations and logistics study to establish requirements necessary for program definition, preliminary design and utilization of a manned orbiting space station and a logistics spacecraft compatible with the space station and the planned launch vehicle systems. Security clearance of "Secret" will be required. RFP MSC-63-407P. RFP due date 3-20-62.

U. S. Army Missile Command
Directorate of Procurement and Production
GOCO Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXG

Selected source procurement for Thiokol Chemical Corp., Alpha Div., Huntsville Plant, Huntsville, Ala., for fabrication and delivery of six XM33E8 rocket motors for NASA. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor. No proposals are available.

Corps of Engineers
Ballistic Missile Construction Office
Torrance, Calif.

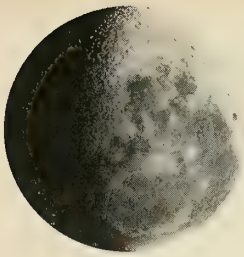
Construction of strategic missile support facilities, Phase I, maintenance handling facility, Warren Air Force Base, Wyo., consists of rehabilitation of five buildings, construction of gate house and fence, and construction of parking area, roads and utilities. Rehabilitation is primarily removal and replacement of partitions, floors, heating systems and sprinkler fire protection. Job—IFB ENG-04-548-63-15B. Tentative bid opening 4-11-63. Plans and specifications will be available about 3-8-63, and may be obtained by request to the District Engineer, U. S. Army Engineer District, Los Angeles, P. O. Box 17277, Foy Station, Los Angeles, Calif. Set of plans and specifications will be furnished upon receipt of a check or money order in the amount of $10.00 (nonrefundable) made payable to "Treasurer of the United States." All plans annd specifications must be returned to the Area Engineer, Warren Air Force Base, Wyo. Approximate value $1,500,000.

U. S. Army Missile Command
Redstone Arsenal, Ala.
Attn: AMCPM-SEPM

Following items are procured for the *Sergeant* missile system, flight monitor assemblies—30 each, instrumentation assemblies—30 each. Deliveries to Salt Lake City, Utah. Notice is given that due to the extensive technical knowledge necessary to manufacture this equipment to exacting specifications within the limited time available, requests for proposals have been limited to the following prior producers: Sperry Utah Co., 322 N. 21st St. West, Salt Lake City, Utah; Gilfillan, Inc., 1815 Venice Blvd., Los Angeles, Calif. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firms.

U. S. Army Missile Command
Directorate of Procurement and Production
GOCO Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXG

Selected source procurement for Thiokol Chemical Corp., Alpha Div., Huntsville, Ala., for manufacture and delivery of one SM33E8 propulsion unit. This requirement is synopsized only for the purpose of affording subcontractor opportunities through inquiry to the prime contractor. No proposals are available.



Boeing has been awarded primary developmental, building and test responsibility for NASA's Saturn S-IC advanced first stage booster. Aero-Space Division's new Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This new Saturn program is expanding rapidly, providing unique advancement advantages and ground-floor opportunities to properly qualified Structural Design, Electronics/Electrical, Propulsion, Aeronautical, Cryogenics, Systems Test, Thermodynamics, Mechanical Design, Industrial and Manufacturing Engineers, as well as to graduate Physicists and Mathematicians.

Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly-hired engineers.

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn, and other missile and space programs at Boeing — including the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle — are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

BOEING

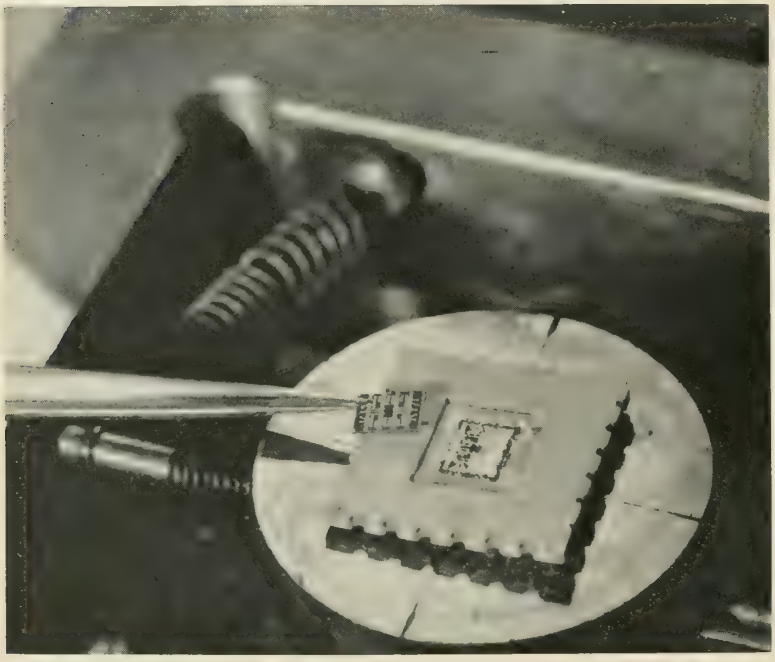
Send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088 - MSI, New Orleans, La. An equal opportunity employer.



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A 'New Fundamental Building Block'



TWO CIRCUITS built from integrated arrays of RCA's new solid-state, insulated-gate, field-effect transistor are positioned for inspection. An average human thumb would fully cover the circular area on which the lower microelectronic circuit is resting. The new semiconductors are voltage-controlled, rather than current-controlled, operate over a wide temperature range, and are highly resistant to nuclear radiation, RCA says.

RADIO CORP. OF AMERICA'S Semiconductor and Materials Div. at Somerville, N. J., offers for development purposes in limited quantities a new insulated-gate field-effect transistor.

Instruments made from the tiny component, RCA says, should also have capability of operating over wider temperature ranges with greater resistance to the effects of nuclear radiation. Present statistics show an operational temperature range of −80° to 190°C, and preliminary tests indicate less sensitivity to nuclear radiation by a factor of ten than for conventional transistors, the company says.

The new metal oxide semiconductor transistor can be fabricated in large interconnected arrays, RCA says, and is regarded by the firm as a "new fundamental building block" for integrated microelectronic circuits for a variety of future electronic applications.

By input voltage variations on the insulated gate, the device as a whole can be made to switch, amplify or otherwise regulate current output in a manner analagous to a pentode vacuum tube. In conventional transistors, similar results are obtained by altering the magnitude of the input current.

Circuits using the new transistors are made by producing conducting paths in a slice of high-resistivity silicon, leaving gaps wherever an active element is desired.

An insulator is produced simply by oxidizing the silicon over the gap. A metal electrode, or gate, is deposited on top of the insulator and connected into the circuit. When the proper voltage is applied on the insulated gate, the gap becomes conducting and the circuit is closed.

Both negative- and positive-type devices have been made. A spokesman claims that the electrical characteristics of the devices are such that complete digital computer circuits can be made from them without the need of other components.

The company expects that the insulated-gate transistor development will result in reduced production costs, will circumvent technological stumbling blocks encountered in the past, and will compete successfully with current-controlled transistors.

Arrays of up to 850 of the new components reportedly have been produced within an area the size of a dime. Experimental microcircuits being fabricated from these arrays include: electronic switches and counters for computers, amplifiers for both defense and commercial communications systems, and control networks for a variety of industrial and military applications.

RCA expects that their new transistor will combine the best qualities of vacuum tubes—greater flexibility and simpler circuitry—with those of transistors—low operating power, small size and long life—while adding certain unique features of its own.

The new solid-state element is the result of a two-year research effort sponsored jointly by RCA Laboratories, Princeton, N. J., and the U. S. Air Force Research Laboratories, Bedford, Mass. Frederic P. Heiman and Steven R. Hofstein, working under Thomas O. Stanley, developed the new component.

Circle No. 225 on Subscriber Service Card

Band Separation Filter

A series of band-separation filters covering the range from 100 mc to 12 gc is available from MELABS. A typical wideband filter, X-364 covers 1-12 gc, has crossover frequencies at 2, 4, and 7.5 gc. Insertion loss is 1.5 db nominal and typical isolation is 30 db. These filters are used primarily to separate several bands of frequencies from a broad baseband. They are particularly well suited for use with log-periodic or similar broadband antennas.

Narrow-band filters offer low-loss, low-input VSWR at all frequencies, and are available in a wide range of characteristics. They are effective in combining or separating many signals, particularly where high isolation and low insertion are requirements.

Circle No. 226 on Subscriber Service Card

Miniature Oscillator

A high-power S-band transmitter-oscillator for radar beacons is available from Trak Microwave Corp. With a manual tuning range of 2.8 to 3.0 gc, the unit has a power output of 1700 w peak minimum. It is smaller than devices previously available for this power level and frequency. Weighing only 6 oz. it is 1 in. in diameter and 3¾ in. long. Power input requirements are 2500v at 2.5 A, Ef 6.3v at 0.9 A. For plate pulse service, the fixed delay is 0.1 microseconds; pulse width is 1.0 microsecond nominal, 0.1 to 2.0 practical; rise time 0.06 microseconds; delay time 0.1 microseconds and duty cycle 0.002 maximum.

Circle No. 227 on Subscriber Service Card

Probe Microanalyzer

Developed by Philips Electronic Instruments, the Norelco Electron probe microanalyzer provides advanced performance, superior light optics, and better than one micron resolution.

The instrument has four X-ray take-off ports, and may be equipped with various combinations of vacuum or air-path goniometers and non-dispersive detectors. Each vacuum goniometer will scan all elements from magnesium upward without changing crystals.

Applications of the instrument include studies of micro-segregations, diffusion couples, thin surface layers, precipitates, biologicals, corrosion, atmospheric pollution, and geological microspecimens.

Comprising two basic units, the main console contains the electron optical system, specimen stage assembly, light optics viewing system, and X-ray optics. An electronic circuit panel of unitized design contains the 300v regulated power supply, high-voltage supply for X-ray detectors, linear amplifiers, pulse height analyzer, timer, scaler, rate meter and recorder.

Circle No. 228 on Subscriber Service Card

Broadband Antenna

Developed by Dynatronics, Inc., a broadband antenna covers any 10:1 frequency band in the 100-4000-mc region and meets increasing frequency- and polarization-diversity requirements for versatile telemetry tracking/receiving/transmitting antennas. It provides characteristics of simultaneous-lobing (monopulse) sensing over wide frequency ranges.

Design is based on two oppositely wound conical-spiral radiators with frequency-independent characteristics. Rotation at high speed (up to 1200 rpm) provides scan rates as high as 20 cps.

Circle No. 229 on Subscriber Service Card

Compact Calorimeter

A compact, self-contained optical calorimeter for measuring the output energy and power of pulsed and CW lasers as well as flash tubes, lamps and other light sources has been developed by Optics Technology, Inc. Specifications: Ranges: wavelength 400 millimicrons to 2. micron, energy 0.035 to 312 joules; outputs, energy self contained meter, power: jacks and oscilloscope.

Circle No. 230 on Subscriber Service Card

Power Tube

A transmitting-beam power tube for use in fixed or mobile equipment is available from the Westinghouse Electronic Tube Div. The type WL-8298 tube is for applications where wide fluc-



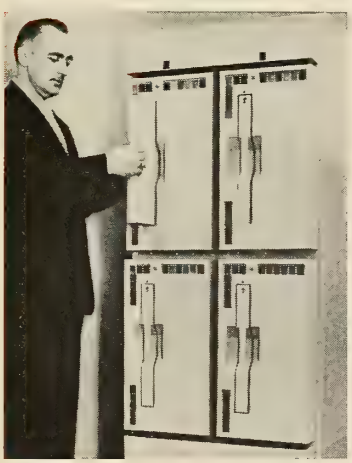
tuations in heater supply voltages are encountered.

A dark heater and an improved cathode in the new tube assure dependable operation of the tube with a continuous heater supply of 8.0v, and an intermittent supply of up to 10.0v. The heater rating is 1.165 amps at 6.75v.

The dark heater has a special dark coating that improves thermal semissivity and operates at about 350°F—less than conventional heaters—but produces the same cathode temperature.

Circle No. 231 on Subscriber Service Card

New Product of the Week: Tape Handling System



A fully automatic magnetic tape-handling system that can withstand violent shock and vibration and perform its data-processing functions despite punishing temperature extremes is available from Sylvania Electric Products Inc., a subsidiary of General Telephone & Electronics Corp.

The system, approximately one-quarter the size of conventional models, is adaptable for use with existing data-processing equipment. The Sylvania system, which employs wholly automatic, magazine-loading cartridges, not only will perform effectively in the most severe field environments but is designed for ease of operation and maintenance.

The system will provide reliability at temperatures ranging from —250 to 125°F and even after exposure to shock levels of several hundred g's.

The fully automatic cartridge takes control as soon as it is inserted and the power is activated. The tape is automatically drawn from the cartridge by air pressure and threaded into air buffer wells by a pneumatic drive, thereby eliminating the need for human handling. The read-write head glides into place automatically and awaits operator commands.

Circle No. 232 on Subscriber Service Card

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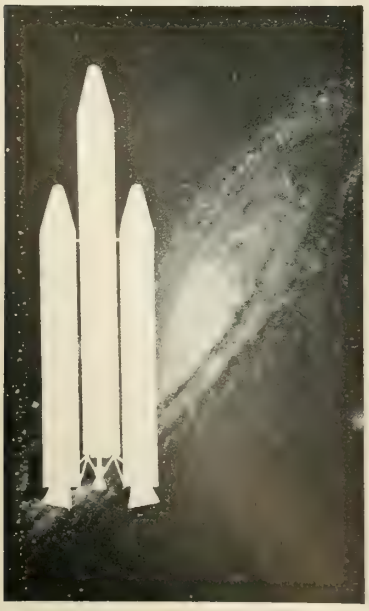
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Data Logging System

A digital data-acquisition system—designed to accurately measure and record information produced by multiple millivolt-level signal sources, such as



thermocouples and strain gage bridges —has been developed by Dymec, a division of Hewlett-Packard Co.

The DY-2010G thermocouple/strain-gage bridge-measuring system provides high-accuracy measurement in the presence of severe common mode noise. Floated and guarded input scanner, amplifier and digital voltmeter assure better than 120-db effective common mode rejection at all noise frequencies, including d-c. Additionally, the average reading characteristic of the integrating digital voltmeter minimizes the effects of noise superimposed on the measured signal.

Circle No. 233 on Subscriber Service Card

Triode Cavity Amplifier

Combos Microwave Inc. is marketing a two-stage cavity amplifier, Model 1532-1 for microwave applications. The unit operates at 1300 mc, and has a gain of 35 db (minimum). Bandwidth is four mc nominal at 30 db, two mc nominal at 45 db gain. RF input power is rated at 0.5 microwatts. A-c and d-c power is: Ep, 150v d-c, Ip, 50 Ma maximum; EF, 6.3v.

Circle No. 234 on Subscriber Service Card

Dataplotter

A digital plotter—designed for scientific, industrial and military uses where fast, accurate, graphic recording of digital coordinate data is needed—has been developed by Electronic Associates, Inc.

The Series 3500 Dataplotter operates on-line as well as from card or paper tape readers, and is capable of plotting points, symbols, or lines at speeds as high as 200 points or 120 lines a minute. It is used for plotting telemetered data for missile ranges, wind tunnels, meteorological stations and other test facilities, and the presentation of management data.

Accuracy for point plotting is ± 0.05% of full board width; repeatability is within 0.015-in. of straight-line interpolation with 0.05% of full board width for the end points. The system accepts information in the form of four decimal digits plus sign in both x and y.

Circle No. 235 on Subscriber Service Card

Optical Meter-relay

An optical meter-relay, developed by Assembly Products, Inc. features almost instantaneous control action at set point, and a dead band of 0.25% of full scale or less. The units can be provided with modulating action that makes them suitable for precisely controlling industrial processes, including temperature.

Taut-band suspension is used for the meter movement, giving resistance to vibration and repeatability of at least 0.2% full scale. Tracking accuracy is ± 1% or better. There is no physical contact in the instrument between pointers at set point. The signal pointer is free to move past set points and to indicate signal strength continuously.

Circle No. 236 on Subscriber Service Card

Control System

An electro-matic control system, combining four standard production units into a single custom-tailored control package for the process industries is being marketed by The Annin Co. division of the Worthington Corp.

The system consists of a standard Annin valve, available in three basic pressure ranges: an electro-hydraulic actuator, a solid-state electronic controller, and an electrical pressure senser. In operation, the system effects high-



speed, precise control of liquids or gas systems at any pressure up to 10,000 psi. Full valve stroke time is measured in milliseconds.

Circle No. 237 on Subscriber Service Card

Heatmeter

Geonetics Corp. has developed an instrument for accurate measurement of heat flow and suited to solving problems in the fields of satellite and rocket

systems, thermal insulation, control, biophysics, and medicine. The heatmeter indicates heat flow from, to, or through most surfaces over the normally encountered range of 1 to 500 BTU/hr.-sq. ft.

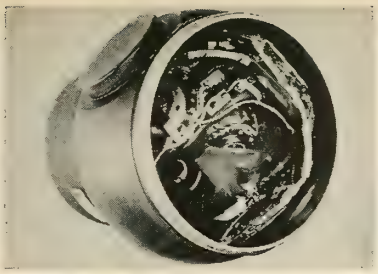
The new device is available in two standard models. Model S has thermocouples in series and is best used with a null-balance potentiometer. Model P has lower internal resistance and is designed for use with sensitive electrical meters.

Circle No. 238 on Subscriber Service Card

Reference System

The LS-19 vertical reference system, capable of sensing vertically within ±1½ min. of arc (rms) with maximum excursions limited to ±3 min., has been developed by Aeroflex Laboratories.

The system is used for providing a vertical reference for Doppler radar systems, high-acuity aerial mapping systems, infrared systems, and missile-test instrumentation. It consists of an inertially-stabilized Schuler-tuned platform, essentially an electromechanical analog device which acts as a pendulum equal in length to the radius of the Earth. This simulated pendulum has a period of 84 min., and never deviates from the vertical by more than three min. of arc, even under violent aircraft maneuvers.



The long, smooth motion within the accuracy limits allows ultra-sharp high-resolution aerial photography without image-degrading high-frequency oscillation.

Circle No. 239 on Subscriber Service Card

Sweep Generator

Telonic Industries offers a sweep generator capable of providing complete checkout of signal response of FM receivers in production and inspection. The Model SV-14 is designed for use in all phases of FM tuner manufacture, including engineering laboratory design, assembly line testing and adjustment of completed equipment or components, and quality control inspection stations.

A switch on the front panel selects oscillators for either the IF or RF band, each having separate attenuator systems and output connector. This allows RF, local oscillator, and IF adjustments to be made in a suitably equipped test fixture without re-connecting cables or changing input signal levels.

Circle No. 240 on Subscriber Service Card

Radar Receiver Circuits

Basic circuits for a microminiaturized monopulse radar receiver have been developed by Autonetics, a division of North American Aviation, Inc.

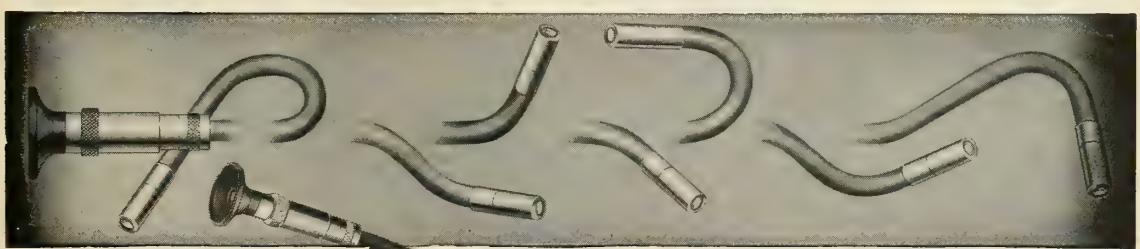
Thin-film hybrid circuits are used in the system, which employs attenuators rather than variable amplifiers for gain control. The system includes standard two-stage amplifiers, the voltage-controlled attenuators, and band-pass filters.

A thin-film deposition technique is being used to produce the circuit's passive elements, with miniaturized transistors and diodes added. Use of the technique in production-model radars will mean increased reliability and decreased logistics expense, as well as a reduction in airborne system weight.

Circle No. 241 on Subscriber Service Card

Transistor Test Station

Optimized Devices, Inc., has developed the transistor test station, which is geared to test up to 15 transistor parameters at one time. It is equipped



Focusing eyepiece for convenience of user.

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FOR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

Please send details and sketch of your requirements.

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8 Pelham Parkway, Pelham Manor (Pelham), N. Y.

Circle No. 8 on Subscriber Service Card

to test transistors singly or in groups of 20 mounted on the appropriate circuit boards. The unit is capable of making 3000 parameter tests per hour. Changing requirements at any future date may be met through the selection of different or additional modules. The entire system is constructed from standard building blocks to achieve maximum flexibility in application and economical system expansion. The test results may be set up to operate on a "go, no-go" basis, on individual readout for data display or programmed for automatic card punching of parameter measurements.

Circle No. 242 on Subscriber Service Card

Digital Phase Counter

Sanders Associates, Inc., offers a digital phase counter that features speed (50 phase angle measurements per second); accuracy (±0.05 degree); resolution (down to ±0.01 degree); and versatility.

Designed to meet the shock and vibration requirements of MIL-E-5400 curve 1, and to operate over a temperature range of 0° to 50°C, it is qualified for use in military equipment.

Measurement is based on counting clock pulses over a 10-cycle average time interval between the zero crossover of two symmetrical waveforms.

The instrument includes serial shift register, and nixie display readouts. It also includes provision for an on-line printer, and for punched tape readouts. Option is provided to read either 0° to 360°C, or −180° to 180°C.

Circle No. 243 on Subscriber Service Card

Microwave Antenna

Ainslie Corp. is marketing a line of communication microwave antenna systems in the 6-KMCS band, available in 2-ft. through 14-ft. sizes. Consisting of a sectional horn feed mounted in a precision-spun parabolic reflector, these antennas are for use in common-carrier studio-transmitter links, and in operational fixed, government, and industrial services.

The feeds are tuned in three broad ranges (over the 5925-7425 mc bandwidth) so that the VSWR remains below 1.1-to-1 for any specific range. The horn is hermetically sealed, and means are provided for attaching guy wires on models 4 ft. or larger in dia.

Circle No. 244 on Subscriber Service Card

PLASTIC FABRICATION

TAPCO, in Cleveland, Ohio, is expanding its rocket-engine-component programs. Successful design and fabrication applications are currently being carried out on Minuteman, Polaris, Titan II and Scout.

Unusual project and development engineering opportunities exist in Plastic Fabrication.

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To arrange for a confidential interview, send your resume in complete confidence to W. G. Kirkwood, Box EM 233 at the address below.

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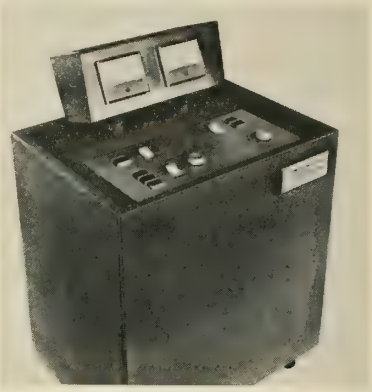
23555 EUCLID AVENUE CLEVELAND 17, OHIO

Circle No. 9 on Subscriber Service Card

Magnet Power Supply

Available from Advanced Kinetics, Inc., the superconducting-magnet power supply (Model SMPS-101) is a completely transistorized, constant-current source capable of supplying from 0 to 20 amps d-c.

The unit features regulation of bet-



ter than 0.1% as the input voltage varies from 105 to 125v a-c. The ripple factor is less than 0.5% under all load conditions.

A rate-of-change control is provided that automatically raises or lowers the current at continuously variable rates. An override mechanism is incorporated, which automatically reduces the output current to zero when energized by a cryogenic liquid-level monitor. A quencher supply (0 to 100 ma) is included. This facilitates operation of the superconducting coil in the persistent mode.

Circle No. 245 on Subscriber Service Card

Cesium Beam Tube

The Bomac Div., Varian Associates, has developed a cesium atomic beam tube for frequency standard applications.

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Intervalometer

Available from Di/An Controls, Inc. the model 12-14 aerospace intervalometer is a rugged, compact interval timer fully qualified and flight tested to control various aerospace equipment functions and operations. The unit initiates, on command, a preselected timing sequence consisting of 12 intervals. The duration of each interval may vary from 50 milliseconds to nine hours, giving a program up to 108 hours long. Standby power is negligible, and the intervalometer state is non-volatile.

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new literature

SPACECRAFT PCM TELEMETRY SYSTEMS—A 12-page illustrated brochure discussing spacecraft PCM telemetry systems is available from Radiation Inc. The brochure explains engineering and production problem-solving techniques used in development of missile/space electronics. It discusses some of the methods used in high-density packaging; the high degree of reliability required and how it is achieved; and the necessary environmental testing of spacecraft electronics.

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MOLECULAR ELECTRONICS—An 18-page publication available from Westinghouse Electric Corp. covers applications, manufacturing methods and other aspects of molecular electronics.

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DIGITAL VOLTOHMMETER—This instrument for in-flight monitoring of flight-test data, monitoring airborne data transmission, ground missile checkout, and tracking or navigation system voltage measurements is fully described in a data sheet released by the Systems Div. of Beckman Instruments, Inc. The Model 5 is said to display a-c and d-c voltage and resistance values in four decimal digits (1.999, 19.99, 199.9, 1999) at better than 1.0% accuracy.

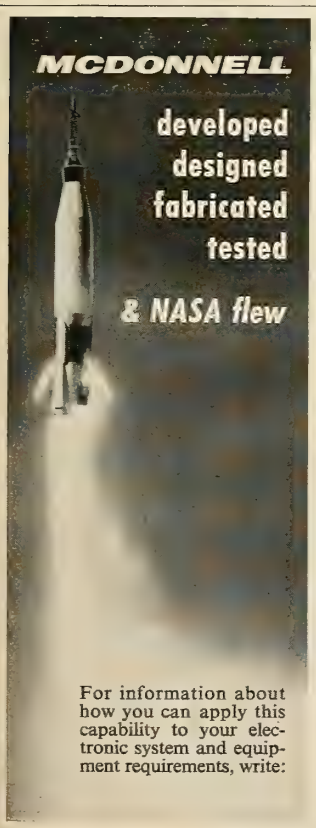
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MEMORY CORE SUMMARY SHEET—A one-page guide to ferrite memory core types is available from Electronic Memories, Inc. Size, recommended drive currents and typical output signals are listed for three word-select and 11 coincident-current types. Also listed are four types of Isodrive Core with operating temperature −55° to 100°C.

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PHOTOCOM CHOPPER—A technical bulletin, F-4000, 6-62, which includes environmental performance data, mechanical, electrical characteristics and circuit configurations of the package "X" photocom chopper for printed circuit board mounting as well as for its package "W" standard socker mounting photocoms, is available from James Electronics Inc. The specifications in the bulletin further provide pertinent working details and typical applications of the two package "X" models available with the printed circuit connections.

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George M. Walsh: Appointed inspection and test manager of Fairchild Camera and Instrument Corp.'s Defense Products Div., Syosset, N.Y.

George A. Bronson: Promoted to Director, Engineering & Operations, of General Technology Corp., Torrance, Calif.

Bernard Kessler: Appointed director of marketing for The Mica Corp., Culver City, Calif.

Gerald Chrysong: Appointed western regional sales manager for Mallory Capacitor Co., a division of P. R. Mallory & Co., Inc., Lakewood, Calif.

Sidney Ladenson: Named chief design engineer for the Manufacturing Div. of Wyle Laboratories, El Segundo, Calif.

John D. Cather: Appointed manager of procurement at the Western Development Laboratories of Philco Corp., Palo Alto, Calif.

Irving Margulies: Appointed engineer, special devices, for Beckman & Whitley, Inc., San Carlos, Calif.

Fred T. Sinnott: Named chief electronics engineer by Kinetics Corp., Solana Beach, Calif.

P. R. Gildon: Appointed manager, research and advanced development at Packard Bell Computer's research and engineering departments, Los Angeles. **R. A. Bennett** appointed manager, product development and engineering; **D. L. Pickens,** manager, systems engineering; and **R. H. Gibbs,** manager, engineering administration and services.

Armand R. Tanguay: Appointed manager of the Advanced Electronics and Information Systems Div. of Electro-Optical Systems, Inc., Pasadena, Calif.

Dr. Larry Kaufman: Appointed director of research at ManLabs, Inc., Cambridge, Mass.

Leland R. Taylor: Vice president and assistant to the president of North American Aviation, Inc., El Segundo, Calif., elected to the board of directors.

Paul D. Cooper, Jr.: Promoted to post of business manager of MELABS, Palo Alto, Calif.

Joseph B. Tierney: Appointed public relations manager of the Products Aerospace, Products Automotive, Automotive Service and Mishawaka Divs. of the Bendix Corp., South Bend and Mishawaka, Ind.

Dr. Gottfried R. Rosendahl: Appointed senior scientist at ITT Federal Laboratories, Nutley, N.J.

Paul A. Hower: Named chief, operations analysis, Office, Vice Chief of Staff, U. S. Air Force, Washington, D.C.

John J. Graham and Ted B. Westfall: Elected to the Board of Directors of International Telephone and Telegraph Corp., New York City.

Robert B. Mitchell: Named director of quality control of Schaevitz Engineering, Pennsauken, N.J.

Dr. Bruce L. Reinhart: Staff member of Martin Co.'s Research Institute for Advanced Study, Baltimore, awarded the Washington Academy of Sciences 1962 outstanding achievement award in the field of mathematics.

Dr. Arthur Goldsmith: Appointed chief engineer of the Military Communications Laboratory at the Chicago center of Motorola, Inc.'s Military Electronics Div.

Keith G. Lindell: Appointed assistant to the manager of Garrett-AiResearch Div. of the Garrett Corp., Los Angeles.

Louis J. Gaal: Named chief project engineer of CryoVac, Inc., Columbus, Ohio.

John C. Rich: Appointed manager, Western Div., Alloy Metals, Inc., Detroit.

James B. Breitmaier: Appointed systems control branch chief of the *Minuteman* ground electronics program at Sylvania Electric Products, Inc., Waltham, Mass.

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1963 Microminiaturization Congress, Sheraton Hotel, Philadelphia, March 5-7.

Institute of the Aerospace Sciences National Propulsion Meeting, Pick-Carter Hotel, Cleveland, March 7-8.

American Society for Quality Control, Annual Quality Control Forum, King Edward Sheraton Hotel, Toronto, Canada, March 9.

American Institute of Chemical Engineers National Meeting, Roosevelt Hotel, New Orleans, March 10-14.

American Rocket Society, Electric Propulsion Conference, Colorado Springs, Colo., March 11-13.

National Association of Corrosion Engineers, Annual Conference and International Congress on Metallic Corrosion and Corrosion Show, Americana Hotel, New York City, March 11-15.

Instrument Society of America, National Conference on Instrumentation for the Iron and Steel Industry, Pick-Roosevelt Hotel, Pittsburgh, March 13-14.

National Security Industrial Association Symposium on the Impact of Government Research and Development Expenditures on Industrial Growth, State Department Auditorium, Washington, D. C., March 13-14 (secret).

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Politics and Procurement

NOTHING CAN DEMORALIZE a company or an engineering team so quickly as losing a contract because of politics. It is unfair, it is uneconomic and it is here to stay—for at least the duration of this Administration.

The White House is playing an increasing role in decisions on major military weapon systems.

There are two ways to look at this. One is to insist that partisan politics is governing every military procurement decision. The other is to acknowledge that the President constitutionally is Commander-in-Chief of the nation's armed forces and therefore ultimately responsible for U.S. defense.

The truth lies somewhere between. The political factor is a prominent one. But it frequently takes this form:

"All other things being equal, why can't we give the contract to Company X."

This can be insidious. Constant calls from the White House to the men making procurement recommendations on a program can make it plain what decision the President would prefer. It takes individuals with tremendously strong beliefs and technical arguments to stand up under this kind of pressure.

Now under consideration is an arrangement whereby the White House would screen the list of companies being invited to bid on a specific contract. Those not politically acceptable would be removed. The technical competition among the remaining firms then would take place in an atmosphere free of political pressure.

We personally regard such a system with revulsion. But "political" can have many meanings. It can take the purely partisan form of an effort to buy votes. It can refer to an attempt to spread government procurement into depressed areas. It can express the need to give a program, such as the national space program, the broad base across the nation which will assure its fullest support in Congress. Or it can include the international effects of domestic procurement decisions.

Defense decisions, ideally, should be made without consideration of vote potential, depressed areas or geographic location. Let us contemplate a situation where, even under such ideal circumstances, two firms are almost equal in technical competence, cost proposals and capability. Inevitably, political considerations will creep into the final decision.

It also is true that many weapon systems have become so costly that the decision to procure or not procure can alter the entire national budget picture. The impact of such procurement decisions must be weighed from a national standpoint. Only the White House can do this, not the Dept. of Defense.

It is therefore plain—for reasons both valid and invalid—that politics play a major role today in procurement decisions.

Company management, to do a capable job, now must take this factor into consideration in its advanced planning and in its entire approach to the Government procurement establishment. It also must crank this factor into the intelligence passed along to its engineering teams.

For political considerations, on occasion, can affect the approach to cost or even to specified performance.

If it is accepted that a firm must be prepared to compete in the political arena just as it does in the arenas of cost and performance, the question becomes one of how best to do it.

A number of major firms now include both domestic and international political considerations in their advanced planning. The corporate planning director of one of the industry's most successful major companies puts it this way:

"We can study the heck out of something technically but that does not tell us how big our *Minuteman* force is likely to be in the future. We could study the economics, but that doesn't tell us. So now we also study the politico-military picture. We might even talk to the State Dept. The politico-military effect establishes the force level."

On this basis, a sensible sales forecast can be made.

The company which is on its toes today is talking not only to State but to the decision-makers in Congress, to the President's political advisers, to its own overseas representatives, to many levels of the DOD establishment and to the individual services.

The services may not be making the procurement decisions as in the past, but they still can help a firm to sell a concept or a worthwhile hardware proposal.

But simple technical competence no longer is enough. In the years ahead, a company must be politically competent as well. This may be lamentable, but it is a fact of life.

If a company has an obligation to its stockholders to develop competence in this field, the Administration has an equal obligation to its stockholders—the people of the United States—to eliminate political evils from the system to the greatest extent possible.

POLITICAL PRESSURE must be removed from those making procurement decisions in the Dept. of Defense. These vital decisions must be made in an atmosphere free of politics, with emphasis on such factors as cost and technical excellence.

If political impact must be considered, this consideration should take place after the DOD decision is made. To continue to seek a favorable recommendation through political pressure on the decision-makers will undermine the industrial competence which backs up this nation's armed forces.

Politics is part of our way of life. Allowed to creep unchecked throughout the U.S. defense establishment, it also can contribute to the destruction of our way of life.

The industry should be prepared both to live with it where it is necessary—and to fight it where it is dangerous.

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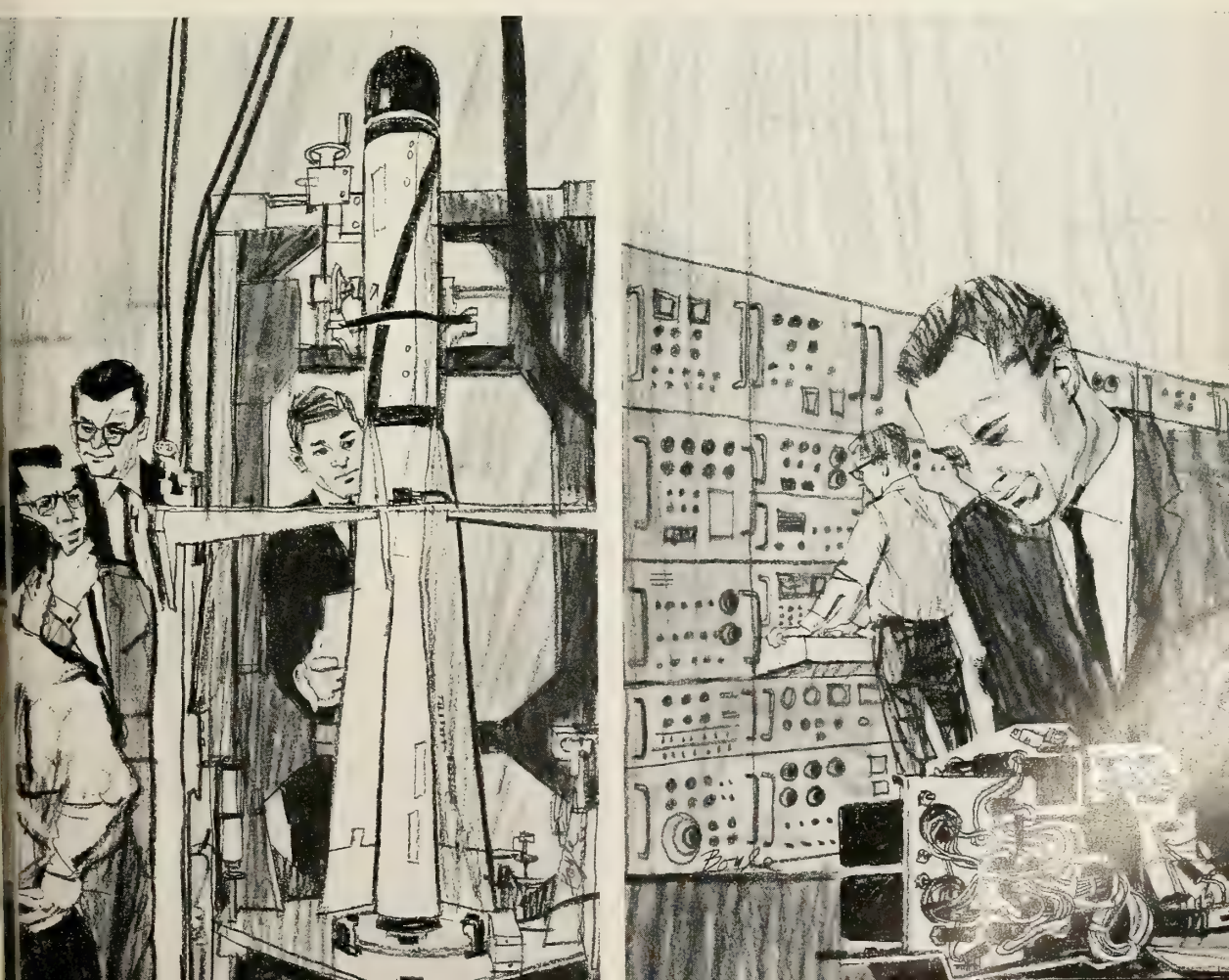
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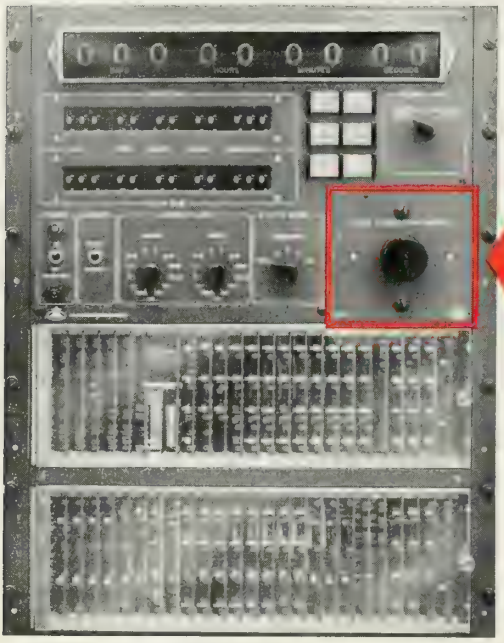


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- GE's 'Pop-Up' Titan II Antenna
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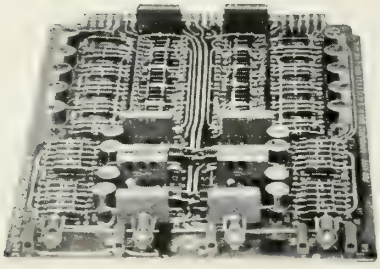


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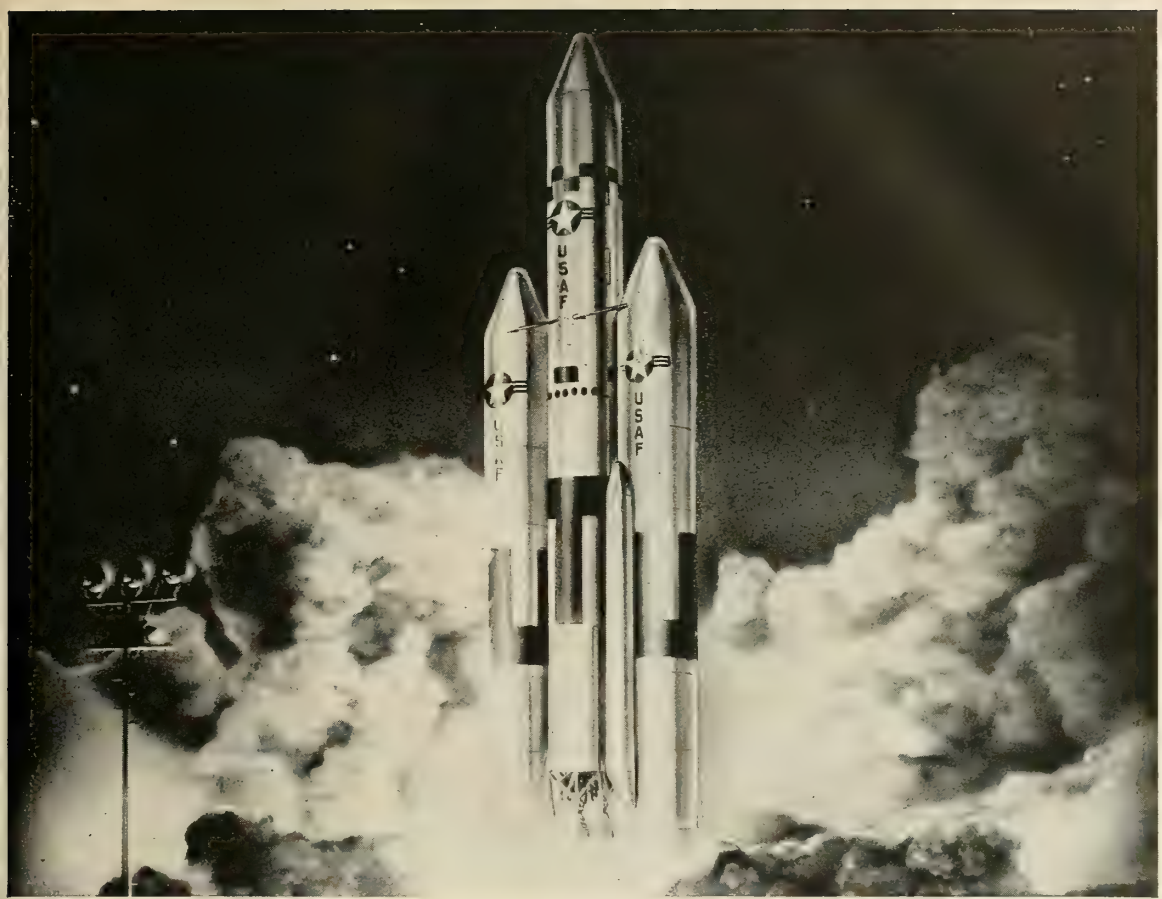
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Thermoelectric System. First in line among SNAP reactor systems under development at A.I. is SNAP 10A, a 500-watt system which makes use of a thermoelectric converter to transform nuclear heat directly to electric power. The compact reactor, weighing only about 250 pounds, is cooled by liquid sodium-potassium alloy. Zirconium-uranium-hydride material serves as the combined fuel and moderator. The system requires no active control after orbital startup and has no moving parts. Two developmental prototypes have operated successfully for a total of 375,000 kilowatt hours.

Turboelectric Systems. The 3000-watt SNAP 2, another AEC space reactor system being developed by Atomics International, uses the same reactor as SNAP 10A with provision added for active control. Power conversion is accomplished by a unique turbine-generator which operates on a mercury vapor Rankine cycle. All rotating components—turbine, generator and liquid metal pumps—are mounted on a single shaft which rotates at 40,000 r.p.m. A fully-shielded SNAP 2 system weighs only 1350 pounds, yet can supply as much electricity in a year as 250 tons of batteries.



SNAP 8 is a direct outgrowth of SNAP 2 but produces higher output. Atomics International is responsible to AEC for the SNAP 8 reactor-and-shield subsystem, nuclear systems testing and nuclear safety. Using a mercury vapor turbine-generator, SNAP 8 will deliver 30 kilowatts of power—enough to enable orbital tests of ion propulsion engines. The National Aeronautics & Space Administration is developing the power conversion equipment and will accomplish overall system integration.

Opportunities at A.I. Openings exist for those with BS or MS degrees in general engineering; electrical, mechanical or chemical engineering; metallurgy; mathematics; or physics plus three or more years experience. Assignments include heat transfer, thermodynamics, high speed rotating mechanisms, stress analysis, mass transfer, nuclear analysis and component development. If you are interested in making your mark in this important program, Atomics International invites you to inquire for additional information.

Contact: Mr. H. C. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California

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Division of North American Aviation

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 10 March 11, 1963

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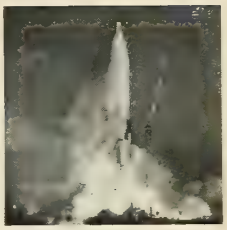
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THE COVER



Atlas F fired from Cape Canaveral March 1 in successful first flight of ABRES (Advanced Ballistic Re-entry Systems) nose cone developed by Chrysler. Cone is designed to reduce radar profile, foil enemy tracking. *See p. 10.*

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letters

'Theoretical Engineers'

To the Editor:

I found the interview of Theodore von Karman by your Senior Editor William Beller and Associate Editor Frank G. McGuire (M/R, Feb. 25, p. 22) most interesting.

Von Karman says, among other things, ". . . we really need all the physicists, chemists, and others, but we also need the creative people—not the inventors, there will always be inventors—who will create hardware. And it is not a shameful thing to create hardware. How the technical universities will solve this is not clear to me."

Messrs. Beller and McGuire then suggest the term "theoretical engineer," to which von Karman replies, "I like that term, 'theoretical engineer.'"

This brief exchange is a very important one. The late and great Professor P. W. Bridgman of Harvard advocated a point of view in Physics wholly consonant with the expression "theoretical engineer." I refer to what he called the "operational point of view" in Physics. He wrote a very remarkable—now well known and much discussed—essay called "The Logic of Modern Physics" (first published in 1927 and now available as a paperback from The Macmillan Co., N. Y., 1960; also see his Chapter V, in "The Way Things Are," Harvard University Press, Cambridge, Mass., 1959). The operational point of view in Physics holds, among other things, that comprehension of all physical laws is possible in terms of (gross or macro) apparatus and the concepts which this performance generates. This implies that all the concepts necessary for the comprehension of physical laws may be defined in terms of the physical operations which one performs on such macro apparatus. This point of view welds into a single structure the points of view of the hardware-producing man, the engineer, the engineering physicist, the theoretical physicist and all other technical personnel. In nuclear physics no one can deny the importance of the vast amount of hardware and its performance (the operations of this hardware and the configurations thereof). The macro operational physicist and the "theoretical engineer" are probably identical twins. What Professor Bridgman's well expressed point of view needed was *its own mathematical formalisms.* One part of this formalism was introduced by the undersigned many years ago and brought up to date in a book called "An Introduction to Scale Coordinate Physics" (Burgess Publishing Co., Minneapolis, 1958). This book introduced the elements of a "scale coordinate geometry" wide enough in scope to include Riemannian geometry as a special case. Thus, apparatus performance, i.e., hardware performance, is given a much needed formal representation. The uses of topology are also to be recommended to the "theoretical engineer."

Finally, I should like to introduce a term which is a possible alternative to your "theoretical engineer," namely, "hardware theoretician." They both mean the same, so far as I am concerned. But I like mine

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better because yours is already encumbered with connotations born of diverse usages of the adjective "theoretical." At any rate, you and Dr. von Karman have opened up another small door to a vast development in the "theoretics" of physical science which is just beginning to acquire momentum. This is all to the good.

William Bender
Professor of Physics
Western Washington State College
Bellingham, Wash.

Olin's Contributions

To the Editor:

We appreciate your announcement of the award of the Stage II *Advanced Minuteman* gas generators (there are two) to Olin Mathieson. It is so seldom that the lower-tier, but albeit essential, subcontractors receive mention for the important function we perform. However, we would like to clarify the location of Olin facilities. Our solid propellant operations, responsible for the development of these units, are located in Marion, Ill., not in Minneapolis, as you reported.

This facility currently has contracts for developing and producing "cool" hot-gas energy sources for a variety of aircraft, missile and space applications. For your information these include: (1) jet engine starter cartridge, Type MXU-4/A, for use in self-contained starters on (various military) aircraft and GAM 77A *Hound Dog* missile; (2) jet engine starter cartridge, Type MC-1, for use in self-contained starters on B-57 aircraft; (3) gas generator to pressurize *Polaris A-3* thrust vector control system; (4) gas generators (two) for operating thrust vector control and roll control on the second stage of *Advanced Minuteman;* (5) gas generator to pressurize *Falcon* GAR-9 hydraulic accumulator; (6) gas generator to operate turbine-driven hydraulic pump on *Subroc;* and (7) gas generator to operate turbine-driven hydraulic pump on *Nike-Zeus.*

The Organics Division also develops and manufactures conventional pyrotechnic fuze components and highly reliable initiating devices for gas generator and rocket ignition systems. This work is done at our East Alton, Ill., facilities near St. Louis.

Ivan Kenis
Sales Manager
Defense Products & Services
Organics Division
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East Alton, Ill.

London Branch, Maybe?

To the Editor:

An item ("Radio Galaxy Theory Advanced") in THE COUNTDOWN, M/R, Feb. 4, p. 21, refers to "Dr. Fred Hoyle of Cambridge University, London."

Even if its noble offspring, Harvard, *has* moved to Washington, Cambridge University remains some sixty miles from London.

Leslie W.C.S. Barnes
M. A. (Cantab.)
Ottawa, Ontario

Is There Really A Substitute For Experience In Command Equipment?

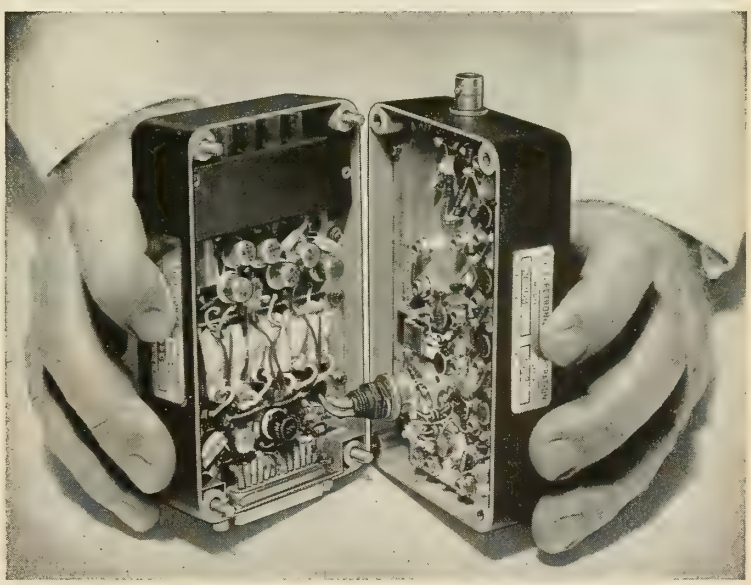
Not that we know of — RS Electronics command equipment has been successfully flown in thousands of flights, in both missiles and drones. These flights demonstrate that, with high reliability RSE equipment, you command with confidence.

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3



A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man rendezvous and dock vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight. By altering its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force-ARPA. And STL continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwaves • Inertial Guidance • Analog Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, Department B-3-2, One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

New Antitank Missile Under Study

A number of industry firms have submitted proposals on *MAW (Medium Assault Weapon)*, a new antitank weapon for the Army. Competition is expected to lead to several feasibility studies to prove out new concepts of the lightweight infantry missile.

Shrike Tests Called Highly Successful

Navy's *Shrike* anti-radiation missile, developed by Texas Instruments, is undergoing highly successful test firings. Pilot production is expected to begin in mid-April. Air Force procurement of the missile is scheduled for Fiscal 1964.

NASA Calls for Voyager Proposals

NASA has invited 22 firms to submit proposals on studies of the *Voyager* unmanned interplanetary spacecraft. Two studies will be conducted on preliminary design of a spacecraft weighing over 1000 lbs. Current plans call for flights to Venus and Mars to begin after 1967.

NASA Seeks AMR Facility Contractor

Watch for NASA to open an industry competition on management of range and support facilities for its new Project *Apollo* launch complex at Cape Canaveral. Pan American has been performing the same services for the Air Force area of the Atlantic Missile Range. But the space agency wants a free hand in selecting its own contractor.

Announcement of Navy Reorganization Due

Announcement of an extensive reorganization of the Navy is expected within a few weeks. Significant changes, bringing the Navy more in line with the management structure of the other two services, are expected as a result of a study conducted by Navy Secretary Korth.

Next Saturn Shot Set This Month

Launch of the fourth in the successful *Saturn* series is scheduled at Cape Canaveral late this month. An engine-out test will be conducted in the *SA-4* launch. The subsequent *SA-5* firing will mark the first two-stage launch of the big space vehicle.

Hope Dim for Syncom Contact

NASA officials are pessimistic on chances of establishing communications with the *Syncom* satellite. Repeated efforts to contact the satellite since it was discovered March 3 orbiting the Earth at an altitude of 22,000 miles have all been unsuccessful. Some agency scientists believe the satellite's power system is dead. Contact was lost shortly after *Syncom* was launched Feb. 14.

INDUSTRY

Ford Working to Lighten Shillelagh

Ford's Aeronutronic Div. is working to cut significantly the weight of the *Shillelagh* missile in order to meet the competition from lighter antitank systems. Insiders say *Shillelagh* still has the nod over *TOW*.

New Grumman Program to Aid Small Business

Spurred by a growing number of inquiries from small business since award of the *Lunar Excursion Module (LEM)* contract, Grumman's small business liaison office now is establishing a referral plan. This is to insure that proposals by small companies seeking subcontracts are seen by the proper prime or major subcontractor. Grumman also will look at the proposals in light of its own work.

Pentagon Teams Study Profit Proposals

Five teams from the Pentagon now are in the field studying possible application of new contracting proposals made by the Logistics Management Institute (M/R, Feb. 25, p. 15). Purpose: to check practicality of the use of a weighted system of guidelines for determining contractor profit. A top Pentagon official claims the intent of the report has been misunderstood by industry and calls it "very practical" for certain contractual situations.

INTERNATIONAL

Space Talks Set for Rome

Efforts to achieve space cooperation between the U.S. and the Soviet Union move this week to Rome. A meeting between Soviet officials and a U.S. delegation headed by Deputy NASA Administrator Dr. Hugh L. Dryden is scheduled to start March 11. Primary emphasis in the sessions, expected to last two weeks, will be on cooperation in communications and weather satellites.

Skylark Scores Success at Woomera

Launch of a *Skylark* rocket at Woomera, Australia, March 1 achieved a height of 123 miles. The rocket carried an experiment to measure electron densities in the upper atmosphere. Other equipment measured distribution of positive ions, X-ray spectrum of the Sun and distribution of atomic hydrogen in the upper atmosphere. A second firing in the program is scheduled.

British to Spend $850 Million on Polaris

Expenditure on the *Polaris* submarine weapon system by Britain is expected to reach $850 million, of which $300 million will be spent in the U.S. Both the firing and control mechanism, as well as the missiles, are to be purchased here. Decision has not yet been reached on whether four or five subs will be built, but the above are given as ceiling figures. No contracts have been let.

Venezuela Considering Seacat Purchases

Reports from Britain say Venezuela is considering purchase of *Seacat* missiles to modernize its Navy. President Betancourt discussed the purchase in recent talks with British officials.

Canada Pledges $8 Million for Satellites

Following success of the *Alouette* satellite, the Canadian cabinet has authorized four additional satellites for ionospheric research in joint U.S.-Canadian space ventures. Modified *Alouettes* and other satellites will involve a minimum of $8 million as Canada's share.

Shots of the Week

While *Atlas* and *Pershing* missiles scored successes last week, a thrust-augmented *Thor* boosting a secret payload had to be destroyed after it achieved only partial success.

• An advanced General Dynamics/Astronautics *Atlas* ICBM fired more than 5000 mi. from Cape Canaveral March 1 to test the effectiveness of a new nose cone designed to present a smaller radar cross-section, thus minimizing the possibility of enemy detection and tracking.

The Advanced Ballistic Re-entry Studies of which this shot is a part also is aimed at finding ways to reduce warhead oscillation, thereby minimizing Circular Error Probability (CEP).

The Air Force did not reveal performance data on the needle-shaped nose cone, which was designed and developed by Chrysler Corp.'s Missiles Div.

Six other experiments were carried in a 600-lb. pod (see photo, this page) attached to the skin of the *Atlas*.

• Another *Atlas* was launched Feb. 28 from Vandenberg AFB in a routine training shot conducted by the 576th Strategic Missile Squadron. Preliminary telemetry data indicated the launch was successful.

• A Martin *Pershing* fired from a sandy sloped surface at Cape Canaveral March 4 met all test objectives, the Army said. The tactical-type firing was designed to further evaluate the missile's inertial guidance system, aero-ballistics, and propulsion system.

• The Air Force deliberately destroyed a secret satellite, believed to be of the *Discoverer* series, after launching it aboard the "souped up" *Thor* Feb. 28 from Vandenberg AFB. All four motors were ignited at launch, but deviation from the programmed trajectory forced safety officials to destroy the booster before payload separation.

The thrust-augmented *Thor* (TAT) is a liquid-fueled *Thor* with three Thiokol solid rockets spaced around the *Thor* case. This was the combination's first test.

ICBM Squadron Operational

The first complete squadron of *Minuteman* ICBM's is operational at Malmstrom AFB, Mont. The final flight of the solid-fuel missiles was turned over to the Strategic Air Command's 10th Strategic Missile Squadron March 4.

The squadron consists of 10 five-missile flights for a total of 50 missiles. An additional flight of *Minutemen*, now operational under the 12th Strategic Missile Squadron, brings to 60 the overall number of operational *Minutemen* at Malmstrom, the first AF *Minuteman* support base.

NASA, DOD in Transit Pact

NASA and DOD have signed an agreement giving the space agency full responsibility for a civilian navigational satellite system.

The pact covers working arrangements between the two agencies concerning non-military applications of the *Transit* navigation satellite system.

NASA will have full responsibility for determining the suitability of *Transit* navigational equipment to meet non-military requirements and development of additional equipment for non-military navigation uses.



GIPSE Space Laboratory

EFFECTS OF ZERO GRAVITY on algae are being studied with the use of this Martin Co. GIPSE (gravity independent photosynthetic gas exchanger) contained in a special pod attached to the side of an Atlas ICBM. The experiment, which flew "piggyback" on a ballistic test flight from Cape Canaveral March 1 (see cover), was designed so that carbon dioxide was circulated through the solution even during the weightless state. Light was furnished by a fluorescent tube. Telemetered data are being analyzed by the space bio-technology department of Martin's Denver Division.

The Navy Dept., which currently directs the *Transit* system, will continue to conduct research and development to meet and support military navigation requirements of the *Transit* system, and will have full responsibility for technical direction of the system.

The Navy will continue the development of military navigation equipment. It will have full responsibility for determining the suitability of such equipment to meet military requirements.

The Navy will also provide NASA with specifications or information needed to prepare specifications for non-military navigation equipment compatible with the *Transit* system. The Navy will review, as requested and as practical, specifications and plans prepared by NASA to meet the non-military navigation requirements, and will provide NASA with equipment and information considered of potential value in meeting non-military requirements.

NASA in turn will give to the Navy information on its plans, results of tests of non-military navigation equipment of interest to the Navy, and equipment developed by NASA which may meet military navigation requirements.

Lingle gets new NASA Post

Walter L. Lingle, Jr., has been named deputy associate administrator for industrial affairs by the National Aeronautics and Space Administration. He will report directly to Associate Administrator Robert Seamans, Jr.

Lingle formerly held the NASA position of assistant administrator for management development. Before coming to the space agency, he was an executive vice president of Procter and Gamble Co.

Dixon Leaving NASA

NASA now has made public the resignation of Deputy Associate Administrator Thomas F. Dixon (M/R, March 4, p. 9).

The space agency said Dixon plans to return to private industry, but would not reveal whether he has already accepted a position. Sources indicated, however, that Dixon has made such a decision and predicted that his future employer will make the announcement at a later date.

...jet Officers Shifted

...erojet-General Corp. has shifted ...anagement structure to enhance ...issile/space business prospects. ... newly created position, that of ...president for future operations, ...be filled by Richard D. Geckler, ...formerly was vice president in ...ge of the Solid Rocket Plant at ...amento, Calif.

... B. Young, former VP, Liquid ...et Plant, with cognizance over ... series and other projects, be... VP in charge of Sacramento ...s.

The former VP-administration, ...S. Reichard, Jr., this week be... VP-contracts and will monitor ...Aerojet contractual agreements.

...ddard Symposium Planned

The first Goddard Space Flight ...ter symposium on scientific satel...s to be held March 13-15 in Wash...ton, D.C., is expected to reveal ... data from several international ...ellite experiments as well as from ...S. energetic-particle satellites.

...nd Re-programming Hit

The approximately $200 million ...ASA reprogrammed during Fiscal ...63 has drawn sharp attention from ...p. Joseph E. Karth, (D-Minn.), ...cond ranking member of the House ...pace Committee.

Saying that the mind-changing ...ight have been excusable in the ...ast because of the newness of the ...eld NASA is exploring, Karth said ...t a Washington luncheon meeting of ...he American Institute of Aeronau...ics and Astronautics that the space ...eld is now more mature, and NASA ...hould be able to decide with better ...ccuracy how much should be spent ...nd where it should be spent.

...racking Sites for Australia

NASA has announced that it will ...uild three new tracking stations in ...Australia under an agreement signed ...by that nation and the U.S.

The stations will include a deep-...space tracking facility 11 miles south...west of Canberra, a manned space...flight and scientific satellite-tracking ...station at Carnarvon in Western ...Australia and a smaller station at ...Darwin.

The deep-space facility, to be ...located in the Tidbinbilla Valley in ...the Australian capital territory, will ...be an additional unit of the deep net...work, which presently consists of ...stations near Woomera, South Aus...tralia; Johannesburg, South Africa; ...and Goldstone, Calif.

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DX priority weighed . . .

Rover Slips Extra 14-16 Months

Kiwi engineering and materials problems are blamed; Finger doesn't know when system will qualify for flight

by Frank G. McGuire

FURTHER SLIPPAGE of the *Rover* nuclear rocket program by 14 to 16 months has been laid to engineering and materials problems in the *Kiwi* test series of reactors.

There is now an increased possibility that a DX priority will be assigned to the program to keep the slippage from seriously affecting nearly all post-*Apollo* space flights.

Next hot firing of a Kiwi-series reactor is now expected next year in the aftermath of the Kiwi B4-A firing last Nov. 30, which resulted in significant damage to the reactor fuel elements, insulation, and other parts. That reactor was the program's "preferred design."

● **DX priority sought**—Harold B. Finger, manager of the AEC/NASA Space Nuclear Propulsion Office (SNPO) told MISSILES AND ROCKETS some procurement difficulties have been experienced because the program is lacking the DX priority, which is the nation's highest.

Finger, who said in mid-October that flight in 1967 was his goal, now says simply, "I don't know when it will fly."

Until the next hot test, SNPO, Los Alamos Scientific Laboratory and Westinghouse will conduct an exhaustive test and evaluation program on all hardware components and the reactor design itself. Concurrently, a series of cold-flow system tests will be carried out in an effort to gather data on vibration, propellant flow and temperature problems.

Official Confirms Cutback of Dyna-Soar

Decision almost takes Air Force out of manned space business; Gemini role may be delayed

CUTBACK of the *X-20 Dyna-Soar* program to the level of an R&D effort similar to the RS-70 has been confirmed by a high Administration official.

The decision leaves the Air Force with virtually no manned space programs and gives NASA a monopoly in the field, with the exception of some subsidiary AF participation in the *Gemini* program.

Pentagon sources have confirmed that Defense Secretary McNamara is leaving shortly on a trip to visit *X-20* contractors; but they declined to reveal his itinerary or his agenda.

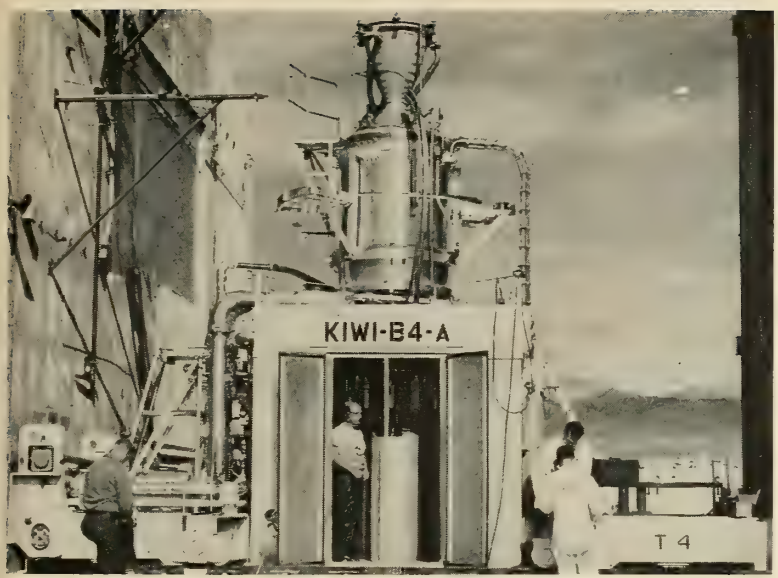
It was learned that the first meeting of the joint AF/NASA *Gemini* Program Planning Board was marked by an Air Force proposal—voiced by Assistant AF Secretary Brockway McMillan and supported by DDR&E Special Assistant L. L. Kavanau—that the *X-20* be covered by the same agreement as *Gemini* (see story and text of agreement, M/R, Jan. 28, p. 14), thus giving NASA a portion of the *Dyna-Soar* management.

The NASA response to this proposal was due to be delivered at the second meeting of the board, and reports indicated that a new agreement on manned spaceflight is in the mill. According to responsible sources, NASA entered the first meeting with a "take-charge" attitude and spelled out to the Air Force just what it wanted.

The Air Force reportedly has been asked to change its plans to enter the *Gemini* program at the seventh flight and wait until as late as the twelfth flight. This appears to be further confirmation that additional *Gemini* capsules and boosters will be bought by NASA for the AF.

One highly unlikely possibility is the transfer of *X-20* funds to support the *Gemini* program. As authorized by Congress, *X-20* funds are to be used for no other programs. Thus, any transfer would require a revision of law.

Recent proposals for expanding the *X-20's* usefulness in space include its use as a ferry vehicle for transferring personnel from Earth to manned satellite stations. The space behind the *X-20* pilot would hold four passengers for the short trip. ■



MOST RECENT Rover hot run, Kiwi B-4A test last Nov. 30 ejected insulation from reactor nozzle and caused extensive damage. Exhaustive component tests have been instituted. Core retention has long been a major headache with Kiwis.

Cold-flow tests use the entire system, minus the nuclear core.

There is no plan, Finger said, to ask for the DX priority at this time. A Congressional source, however, indicated strongly that the DX rating is under active discussion, and added: "It surely would help."

Apparently, the final decision on such a request will be made sometime this spring or summer, when some results may be forthcoming from the component test and evaluation program.

Even though the Kiwi testing has been drastically revised, there is a possibility that the overall program may not slip a proportional degree, since some of the re-design of components may have been required later in the cycle anyway. Also, portions of the overall program are not solely dependent on the outcome of Kiwi hot runs.

● **Problems**—Difficulties that plague SNPO's effort on the program are basically materials limitations, some engineering problems, a few procurement difficulties, and labor strikes. Core retention is a common problem of almost all the B-series reactors, and was even present in a few of the A-series tests. This is simply a losing battle in trying to keep the core within the pressure shell while the liquid-hydrogen propellant is exerting tremendous expulsion force.

Two reactors already fabricated for the Kiwi-B tests will now be slightly modified and used in cold-flow experiments. These reactors are believed to be part of the hardware intended for developmental testing beyond Kiwi B-4A, with as many as six hot runs slated during 1963.

Hardware problems are accompanied by some basic materials limitations on operation in the high-temperature nuclear environment. The engineering design of the core-retention structure is one of the prime variables in each succeeding reactor design, and a severe limitation is the material capacity to retain strength.

The Kiwi B-1B design, tested with liquid hydrogen last August and September, showed that a startup with liquid propellant (rather than the previously-used gaseous propellant) was less difficult than expected. Even so, core damage occurred similar to that which had struck several A-series reactors. The damage has not been explained through laboratory tests, and analysis prompted SNPO to move to the "preferred" Kiwi B-4A design—which again mostly differed in the "substantially different" core design.

● **Test results**—Upon testing with liquid hydrogen, Kiwi B-4A almost immediately began showing flashes of light in the exhaust jet. The power run was continued—with the flashes increasing in frequency—until SNPO and Los Alamos decided more could be learned by shutting down the reactor for examination than by allowing the test to continue. Despite the light flashes, there was no power loss during the run.

Disassembly showed broken insulation components had been expelled from the core, fuel elements had been cracked, and there was other "extensive damage" to the reactor. SNPO said it appeared that severe vibration occurred, probably generated within the reactor itself.

Los Alamos and Westinghouse are now re-designing the mechanical structure to minimize mechanical vibrations. Nevertheless, Finger said in describing the present status of the program:

"Although there is very strong feeling among all participants . . . that this vibration is the explanation for the damage, we have determined that before further full-scale hot tests are run, component, subassembly, and full scale mechanical testing and cold-flow testing will be conducted to evaluate the failure mode hypothesis that has been made of the Kiwi B-4A reactor damage."

● **Anderson confident**—Sen. Clinton P. Anderson (D-N.M.), a close friend of Los Alamos personnel and now chairman of the Senate Space Committee, expressed confidence in the *Rover* program, telling M/R: "Some of these delays and difficulties might be due to inadequate funding in the past, but the engineering problems are more controlling." He added that success of the next series of *Rover* tests will determine the future funding level.

Sen. Anderson is already on record as favoring a greater part in the space program for *Rover*, as well as for giving it a DX priority:

"We must assign *Rover* a definite role in the mission to the Moon and give it the same level of highest national priority held by the *Saturn* rocket development and the man-in-space program."

Late last year, President Kennedy said the present funding level for *Rover* would continue until test results were favorable, in which case funding would be increased to provide for heavy hardware procurement. This would seem to be a reverse of other high-priority programs, where more money is provided when the program runs into difficulty.

Some program personnel indicate a stretchout for RIFT (reactor in-flight test) is being considered if no further progress on *Rover* is shown by July.

Finger praised the Los Alamos efforts in *Rover*, and discounted reports that LASL had been under criticism: "They've made a tremendous amount of progress under unprecedented circumstances," he said, adding, "The only time I will say we are successful in this program is when we have developed the reactor for *NERVA*, have put it into a RIFT stage and have actually flown it successfully." ■

Holmes tells Congress . . .

F-1 Troubles Won't Delay Saturn V

Likely causes of instability are pinpointed; officials outline status of future manned programs

by Hal Taylor

NASA'S MOON BOSS, D. Brainerd Holmes, told Congress last week there are three possible causes for the combustion instability in *Saturn V's* F-1 engine.

Holmes said that while the instability has appeared in only seven out of 250 firings of the engine, "even this small incidence cannot be tolerated."

Testifying before House Space Committee hearings on NASA's Fiscal '64 budget, Holmes said he is certain the problem can be solved for the giant *Saturn V* booster to meet a 1966 flight date.

He said one of the most likely sources is the injector, the engine component which mixes the liquid oxygen and the kerosene within the thrust chamber so that the propellant can burn completely. "The usual means of conquering instability is to change the design of the injector by changing the location or the size of the injector holes. We have a continuing program of fabricating modified injector designs, which are fired extensively in highly instrumented thrust chambers and engine test stands," he said.

Another suspect part of the engine is the large dome through which the liquid oxygen flows. Holmes told the committee instruments have revealed pressure oscillations, which could be transmitted to the gases in the chamber. NASA is re-designing this dome to provide smoother flow and is installing baffles to damp out flow oscillations. Still another approach being followed is to introduce a special kind of injector hole, called a cavitating venturi. This device should prevent oscillations from the combustion gases feeding back into the liquid or vice versa.

● **Future projects**—In discussing other manned spaceflight programs, Holmes said that at this point in space exploration development, flights to Mars during the 1970's are technologically feasible. He warned, however, that the cost in money, time and manpower will far exceed that of Project *Apollo*, and asked the rhetorical question: "Should we do it?"

He noted that the Moon is not the end, but the beginning, of space exploration, and he explained some of the studies now associated with the lunar project which will lead to other, farther-reaching space stations.

Now under study, he said, are payloads for Lunar Logistics Systems which include additional life-support equipment, shelters, roving vehicles, power supplies, and communications equipment. These will be required to provide stays on the Moon longer than the two to four days provided by the LEM.

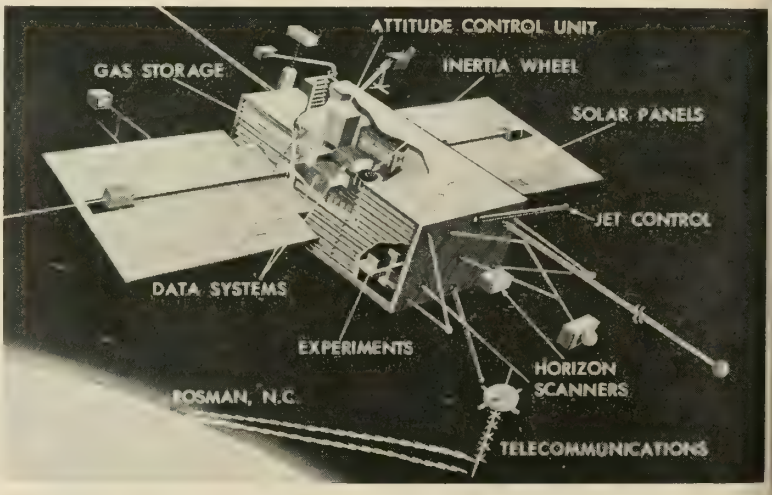
Another possible future project is the manned Earth-orbiting station, which, after two years study, has now been proven technically feasible. Proposals for such stations vary widely: the most modest would extend the *Apollo* spacecraft stay-time up to 100 days; the most ambitious calls for an elaborate station providing artificial gravity that might support a large crew for indefinite periods.

The space agency official said that although much scientific and technical interest has centered on manned planetary exploration, "we feel it is much too early to discuss either mission or concepts or schedules" for such a program. During the next fiscal year, Holmes continued, "we plan to conduct studies to enable us to discuss this problem intelligently."

● **New satellite series**—In other testimony, an official declared that NASA later this year will launch the first of a series of interplanetary monitoring satellites aimed at answering newly discovered scientific problems associated with solar radiation. It will initiate a total of seven flights at the rate of one every six months for a total cost of $30 million, Dr. Homer E. Newell, director of the agency's Office of Space Sciences, told the committee.

The present budget includes $11.4 million for the monitor program, which will carry over from the period of the expected "quiet Sun" in 1964 to the interval of the "active Sun" which follows it in cycle. NASA already has spent $5 million in preliminary studies this fiscal year—after the importance of the need for the interplanetary monitoring satellite was introduced into the space sciences program as a result of evidence gathered on past exploratory missions.

The purpose of the monitoring satellite is to remain in eccentric near-Earth orbit to ascertain corollary solar radiation information gathered from pioneer probes which will develop similar information from deep space examinations. ■



DRAWING of Orbiting Geophysical Observatory NASA plans to launch this year.

Choice in mid-April . . .

Eight Vie for Pioneer Solar Probe

Program will cost more than $50 million and calls for minimum of four flights; effort to complement Mariner

EIGHT MISSILE/SPACE firms have submitted bids to develop NASA's *Pioneer Solar Probe,* which is expected to cost over $50 million.

The competing companies are North American Aviation, Inc., Philco Corp., Ford Aeronutronic Div., Space Technology Laboratories, Henig Research, Hughes Aircraft Corp., Bendix Systems Div., and Westinghouse Electric Co.

A NASA spokesman said the prime contractor will be selected in mid-April after six weeks of evaluation by officials at Ames Research Center and NASA headquarters.

Four flights have been approved, and three more are under study. The probe will be launched by *Thor-Delta* boosters at six-month intervals beginning in late 1964.

NASA had about $3 million committed to the program in Fiscal '63 and has requested an additional $15 million in the Fiscal '64 budget currently being reviewed by Congress. Total cost of the program is estimated at well over $50 million.

● **Goals**—The *Pioneer* missions are part of a broad program to measure the characteristics of solar fields and radiation in both space and time, an effort which began with early *Explorer* satellites and the *Pioneer V*. Program objectives are to provide knowledge of the origin of the Sun; its dynamics, composition, and effect on the Earth's environment; and the relation between solar flares and radiation hazards to manned space flight, with the hope of predicting these hazards in advance.

The program calls for a series of 100-120-lb. space probes to monitor the interplanetary environment near the orbit of the Earth. The spacecraft will be injected with energy just above that required for escape from the Earth in a trajectory that would provide a separation distance between Earth and spacecraft of 30 million miles after 6 months. Scientific information from *Pioneer,* in conjunction with that from presently scheduled *Mariners,* will provide simultaneous measurements at widely separated points in interplanetary space. In addition, the *Pioneer* flights will provide backup for the interplanetary portion of the *Mariner* missions.

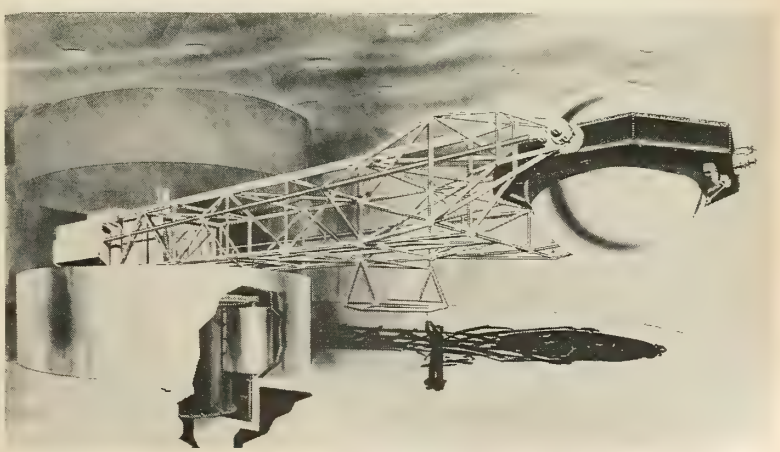
NASA said the relatively simple subsystems intended for use on *Pioneer* should result in great reliability. This aspect is important, since a failure of the *Mariner* would otherwise completely eliminate the possibility of any interplanetary observations during the International Quiet Sun Year.

Project and spacecraft systems management is at the Ames Research Center. Data-acquisition will be managed by Jet Propulsion Laboratory, and *Delta* systems manager is Goddard Space Flight Center.

Related work with similar systems in the past includes that done on the *Pioneer V, Explorers VI, X* and *XII* and the *Interplanetary Monitor Probe (IMP)* series. *Pioneer* represents an extension of these earlier developments, particularly of *Pioneer V*. The *Pioneer V* was extremely successful. It produced several discoveries of major significance in our study of the Sun and interplanetary space. Improvements planned for the new *Pioneer,* plus the vastly improved NASA data-acquisition facilities represented by the deep space network, should combine to provide an even more valuable contribution to the interplanetary science.

● **Operation**—The spacecraft will be spin-stabilized. After separation, the spin axis will be reoriented, in the direction normal to the plane of the ecliptic, by a gas-jet system. The high-gain antenna would be designed to radiate approximately in the plane of the vehicle's equator, i.e., in the ecliptic plane, when the spin axis is nominally oriented. It is estimated that a gain of 10 db will be provided in the region within 3° of the vehicle's equatorial plane. Omnidirectional antennas would also be carried.

Data will be transmitted to the Deep Space Instrumentation Facility by means of amplitron-powered transmitter operation at 3300 mc. With 10 watts of rf radiated, the spacecraft-ground link will provide information at a range of 50×10^6Km, the nominal range after six months of the flight. The spacecraft transmitter will operate continuously at data rates selected by ground command. The system will include provisions for a small number of other ground commands, including those to effect spin axis reorientation, and power level of radiated rf. Power will be provided by solar cells. Thermal control can be provided by an active or passive system. Capability of data storage up to 6000 bits is being considered. ■



Giant Apollo Training Centrifuge

ARTIST'S DRAWING shows centrifuge for huge flight acceleration facility planned for Project Apollo at NASA's Manned Spacecraft Center in Houston. Design criteria were developed by Ford, Bacon & Davis, Inc., New York City, in consultation with McKiernan-Terry Corp., division of Litton Industries, and Raytheon Co. Fifty-ft. boom will carry simulated Command Module and three-man crew.

Back-up for 'soft' units . . .

Titan II Sites Get 'Pop-up' Antennas

Units are key to hardened communications system; GE claims design produced major cost reductions

by Michael Getler

DELIVERY to *Titan II* sites of scores of intercomplex-communication "pop-up" antennas is well under way.

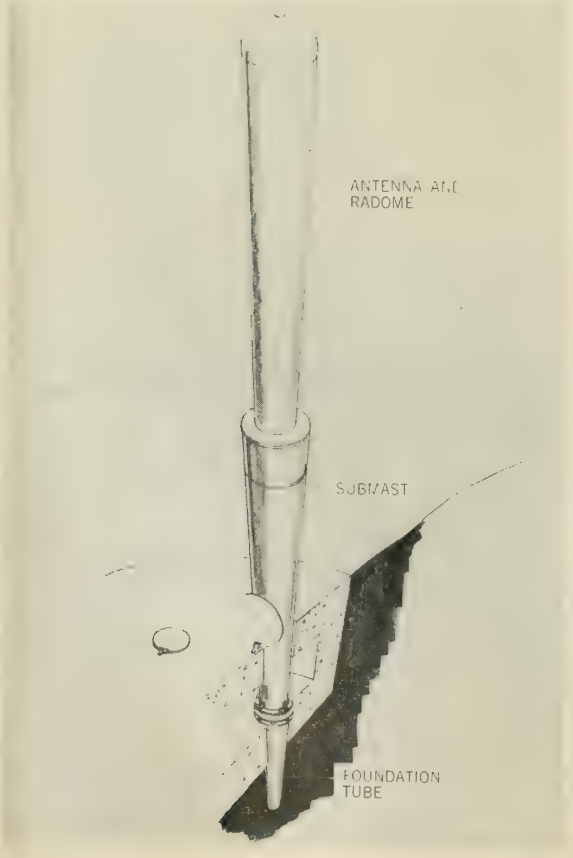
They will be placed in silos at all three bases where 54 6000-mi.-plus *Titan II* ICBM's are expected to be operational late this year.

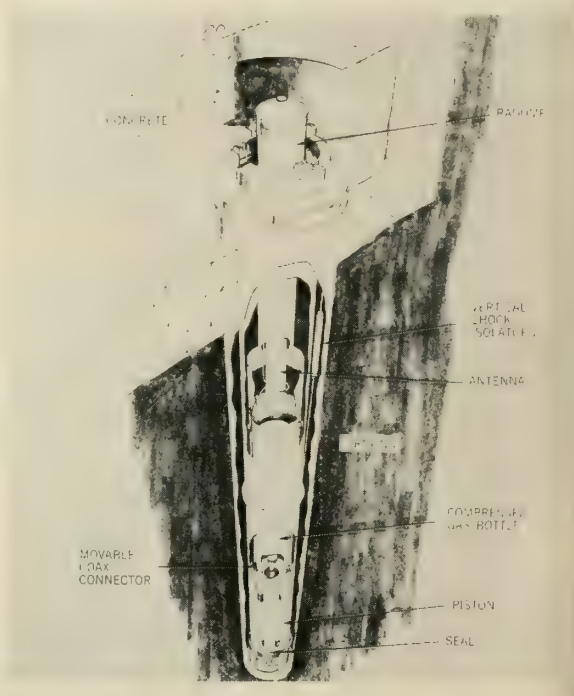
The vertically stored antennas, which rise about 80 ft. above ground level when they are erected, are a key element in the hardened communications network that links all 18 individual launching sites and a command post within a single, widely dispersed *Titan II* base.

The three *Titan II* bases are at the Davis-Monthan AFB, outside Tucson, Ariz.; McConnell AFB, near Wichita, Kan.; and Little Rock, Ark., AFB. Each base will house two nine-missile squadrons, bringing the total number of operational AF/Martin *Titan* missiles on launchers to 108 by the end of this year. Already there are 54 *Titan I* missiles operational at five U.S. bases.

Though both versions of the missile are operated from hardened sites, the earlier *Titan I* must be raised by elevators from its silo to an above-ground firing position. *Titan II*—whose use of storable-liquid propellants and an all-inertial guidance system contributes to a firing reaction time said to be less than one minute—is considered fully hardened, in that it can be fired directly from its silo storage position. *Titan II*, which has scored seven successes and five partial successes (including its first silo launching last month), is expected to move out of the flight-test stage this summer.

● **Insurance**—The "pop-up" antennas actually will be used as a back-up for an above-ground network of fixed, "soft" antennas that reportedly are able to

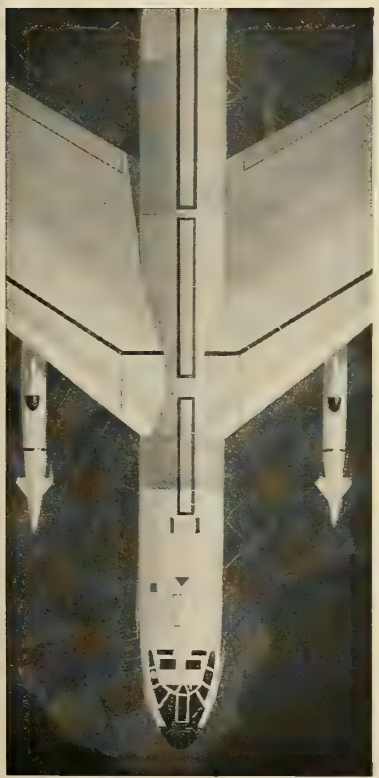




ARTIST'S CONCEPTS of Titan II "pop-up" antenna: above in stowed position at launch site and at left erected above ground. The antenna will provide back-up security for maintaining base communications in the event of a nuclear strike. Two such antennas will be stored in separate steel-lined silos at each missile-launching station. One will raise automatically if the ground antenna fails.

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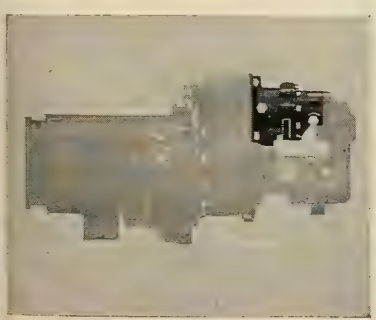
A Kellogg pump, a product of the Aerospace Division of American Brake Shoe, is an important part of the Garrett-AiResearch constant-speed drive—an efficient power source for aircraft cabin air compressors.



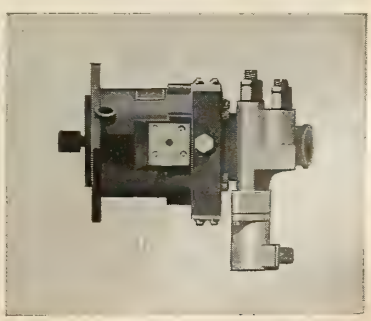
Atchley servovalves, with their exclusive JET-PIPE operation, pass contaminants as large as 200 microns without malfunction. Specified for their reliability in air- and spacecraft and for such specialized functions as driving huge antennas.



The Kellogg AP6VSC-6 pump, a single-stage, cam-actuated unit, is standard equipment on high-performance military aircraft and the Saturn I missile. The US Army's Chinook helicopter, produced by Boeing's Vertol Division, uses this pump as well as landing gear from Brake Shoe's Canadian subsidiary, Jarry Hydraulics, Ltd.







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withstand "semidistant" nuclear blasts. These "soft" antennas, similar in design and capability to the units stored underground, represent the only portion of the *Titan II* communications system that remains above the surface.

Each missile-launching station will have two "pop-up" antennas stored separately in steel-lined silos designed to withstand severe overpressures. Upon detection of a fault in the fixed ground antenna, the first of the "pop-up" devices is raised automatically. In the raised position, these antennas have the same survival capability as the basic above-ground units. A manual erection control is available to ground crews to override the automatic actuators, if necessary.

The "pop-up" antennas are part of the entire Intercomplex Radio Communications Systems (IRCS) project, which the Air Force Systems Command's Ballistic Missile Div. has contracted to General Electric Co.'s Communications Products Dept. at Lynchburg, Va. The total prime contract now is valued at about $10 million. GE's Ordnance Div., Pittsfield, Mass., designed and built the antenna erection equipment; the firm's Technical Products Operation, Syracuse, N.Y., built the transmitters; and the Andrew Corp. of Chicago built the antennas.

IRCS is described as a three-channel system with both UHF and VHF transmit/receive capability. Basic communication equipment includes the vertically polarized bi-frequency antennas, low-power transmitters, wide- and narrow-band receivers, RF multipliers, tone equipment, control consoles, and two-channel multiplex equipment and data adapters to provide simultaneous handling of both voice and data signal command-and-control information.

• **Savings effected**—GE engineers report that wide use of many commercial-grade components, made possible by the extensive antenna housing protection, resulted in "substantial" cost savings to the Air Force.

To raise and lower the 7000-lb. antennas, GE uses a self-contained supply of dry nitrogen as the energy source. Early problems in containing this material and shielding it from various weapons effects have been solved.

Engineers at Pittsfield also told MISSILES AND ROCKETS that development of a unique piston seal for the erection drive system allows use of standard commercial mill-grade tubing as the antenna silo housing—with a resultant cost saving estimated at "hundreds of thousands of dollars." The seal is said to be flexible enough to conform to the various interior discontinuities found within this relatively inexpensive steel piping. ■

Six flights envisioned . . .

NASA Asks for Bids On Biosatellite Study

by Heather M. David

THIRTY COMPANIES have been asked to submit bids for study contracts on NASA's *Biosatellite* within the next two weeks.

NASA will award from two to four six-month study contracts in a program that may lead to construction of six flight satellites, a back-up and mock-up versions. The study contracts are not to exceed $80,000.

If the program is approved, the first flight will come in the fall of 1964, with subsequent flights scheduled at three-month intervals. The satellite will orbit for periods of from three to 30 days—depending on the experiments aboard—and will be recovered for study.

Though the flight phase of the program has not been approved, NASA has asked Congress to approve a budget of $14.4 million for the satellite and $10 million for launch vehicles in FY 1964. Ames Research Center, which is administering the project, is said to be ready to allocate $2 million for floor space and personnel to prepare experiments in flight packages.

Industry is being asked to design a satellite that could be used for three types of payloads:

1) An experiment dealing with effects of weightlessness on a small primate.

2) Studies of the synergistic and antagonistic effects of weightlessness on the susceptibility of plants and animals to radiation damage. NASA has previously indicated that it is interested in orbiting biological experiments together with a gamma radiation emitter of the 10-20-Curie range—two Roentgens per minute.

3) Studies of the effects of weightlessness on the biological rhythms and cellular processes of small animals and biological systems.

Since there will be such a variety of experiments that must be accommodated—with different temperature ranges and times in orbit—flexibility will be a prime requirement. Primary emphasis of the study phase is to be on the spacecraft and its systems, but other aspects also must be treated.

Evaluation of bids as well as experiments is being handled by Ames Research Center, under the jurisdiction of the Office of Space Sciences and with inputs from the Office of Advanced Research and Technology. The contractor will have little to do with the experiments, as suggestions for about 60 of these already have been received at Ames and are being studied.

• **Vehicle choice**—Selection of three alternate booster systems—and a firm recommendation on one of the three—will be made by the study contractor. Though the budget request mentions use of *Atlas-Agena* vehicles, current thinking sets a size on the order of a *Thor-Delta*.

Weight of the satellite, type of oxygen supply, temperature limits and other parameters are not spelled out by NASA, though a project description in the budget request calls for a two-gas, sea-level atmosphere.

Choice of launching site and recovery area is to be recommended by the study contractors, who also will be asked to prepare preliminary designs and development and test plans for a prototype that could be made flight-ready by the end of 1964. In addition, study contractors are asked to specify the type of recovery operations necessary and to recommend tracking command and telemetry facilities to be used. And they will prepare estimates of costs and incremental funding for design and development, manpower, ground support equipment and other launch support on a per-flight basis.

Components of spacecraft design will involve spacecraft; environmental and life support; stabilization and control; re-entry vehicle and recovery sensing; and recording and telemetry systems.

At one time NASA had studied the possibility of using capsules already designed for *BIOS I, NERV* (both ballistic trajectory), *Discoverer, BOSS*, and even modified *Mercury* capsules for its *Biosatellite* program. However, sources indicate that the modification requirements necessary to extend these systems to function up to 30 days would be so overwhelming that to start out from scratch would be more economical.

NASA also once spoke of a larger second-generation *Biosatellite* program, in which several monkeys or perhaps even a chimpanzee might be orbited for several weeks. But no commitment is now being made. ■

Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand — getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at $\gamma = -6°$ to touchdown?

Curves Provide Key

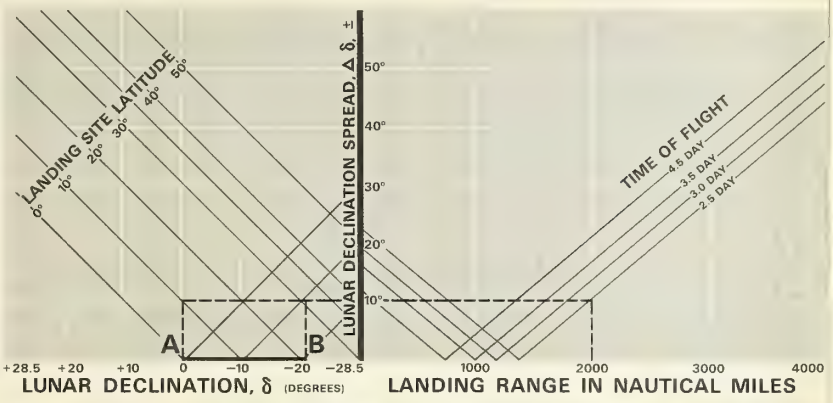
The curves at upper right provide the key. Window AB describes the range of lunar declinations, from $+0.5°$ to $-20.5°$, acceptable for returning to an earth landing site at a latitude of $+10°$, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at $\gamma = -6°$ to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of $-10°$. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

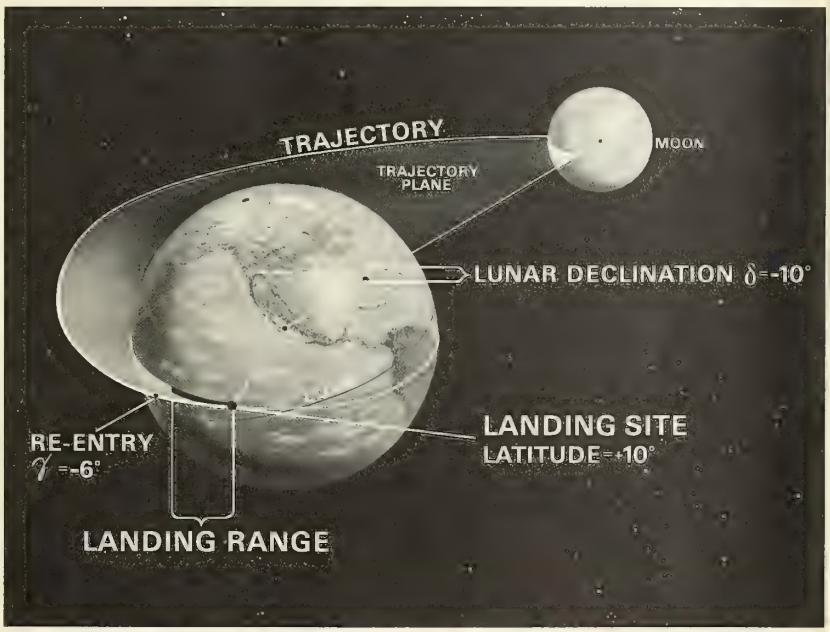
Variety of Opportunities

At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far-ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.

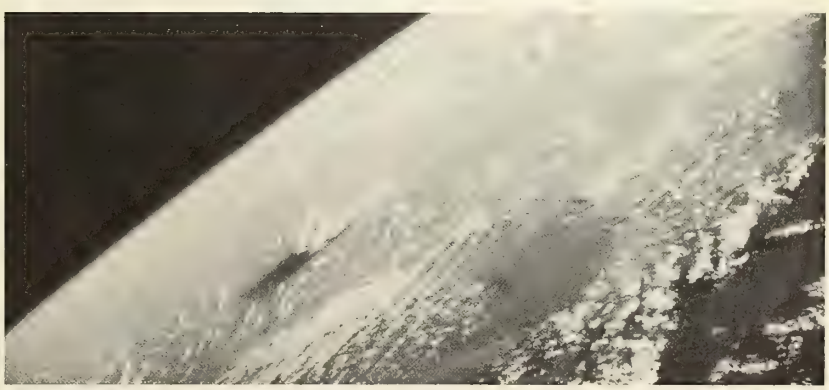
Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics|Astronautics, 5816 Kearny Villa Road, San Diego 12, Calif.





LUNAR LIFT OFF AT $\delta = -10°$ *Heading for an earth landing site latitude of $+10°$, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from $\gamma = -6°$ to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

GD

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DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

AERO-THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

GUIDANCE and TRAJECTORY ANALYSIS

Analytically talented graduate engineers, physicists, and mathematicians at all levels are required to participate in the support of existing guidance systems and the development of advanced guidance techniques. Minimum of two years of appropriate experience is preferred. Positions exist in the following areas:

SPACE BOOSTER/WEAPONS SYSTEMS GUIDANCE ANALYSIS: to provide guidance support for programs covering a broad spectrum of ballistic weapons systems and space booster endeavors. Formulation of guidance equations, evaluation of new deployment methods, and the development of future guidance techniques are carried out. Guidance systems presently under consideration include radio-inertial, pure inertial, stellar-inertial, no gimbal inertial, terminal and homing. Positions involve wide application of digital computers in the simulation and analysis of trajectories, real time guidance computations, and performance of booster and payload systems and subsystems.

GUIDANCE SYSTEMS AND RESEARCH: to develop techniques, equations, simulations and trajectories necessary to perform launch, satellite rendezvous, lunar landing, re-entry and return to prescribed earth sites. Both automatic and manual guidance systems are being investigated using analog and/or digital simulation techniques. The methods of optimal control theory and statistical filtering are being developed and applied to trajectory determination and control. The characteristics of lunar and interplanetary trajectories, including the interrelation of such parameters as velocity requirements, launch windows, time of flight, and inclination angles, are being investigated.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

Graduate engineers will also find long-range opportunities in the following specialties: **STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, WELDING ENGINEERING.**

EXPLORE THE IDEA of growth and advancement with one of the nation's prime aerospace firms, a company whose name is synonymous with leadership in a broad range of pace-setting industrial activities. Among dozens of active study contracts and in-process hardware projects which assure far-ranging challenges to Astronautics staff members at all levels of experience are Nova, Centaur, Atlas SLV III, Arents, lunar logistics vehicles, solar monitors and an impressive array of orbiting and space probe vehicles. Consider the scope of these projects, match your interests and abilities with the activity descriptions at left — visualize yourself at Astronautics, where the professional climate favors your career and the sunny San Diego climate favors your family's year-round enjoyment of life.



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**If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5816 Kearny Villa Road, San Diego 12, California.*

GD

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Technical Countdown

ELECTRONICS

The End of Universal Checkout Trend?

A marked change is occurring in industry prognostications concerning checkout systems of the future. The consensus seems to be that by the 1970's, industry will revert to the special-purpose systems so prevalent in the late '50's. The reasons: microminiaturization advances will permit general use of totally integrated checkout with operating systems, and the economies in dollars, weight and volume resulting from such advances will provide the impetus. Many now feel that the only future for so-called universal checkout systems will be at the factory or depot level, rather than for broad field use, as previously forecast.

European Communications Satellites Urged

Backbench Conservative Members of Parliament in London are pressing the government for approval of a plan to launch a British and Commonwealth communications satellite program. Total program costs are estimated at about $560 million. Also, Eurospace, the consortium of European firms interested in the commercial exploitation of space, is planning its own communications satellite system. European banks apparently are willing to put up nearly $1 billion to get the system started, with further development financed by anticipated income. Biggest hurdle is getting government charters to operate ground stations.

Highly Accurate Portable Antennas Studied

Studies of easily movable satellite-tracking antennas offering down to 0.05-beamwidth accuracy are being performed at General Electric's Ordnance Dept. in Pittsfield, Mass. A primary goal under the $70,000 Army contract is to obtain tracking accuracies equal to the best existing fixed-installation pulse radars. Present designs embody 30-40 ft. dia. reflectors with broadband operation (1-10 gc). The studies are part of the Army's support effort for DOD's communication satellite program.

Think Small: Track a Musket Ball

This expression, appearing on the wall of a radar laboratory at Redstone Arsenal, reflects a new and successful approach for economical tracking targets, according to Army officials. Fired by a gas-propulsion tube roughly similar to a shotgun, steel ball bearings, dubbed Mini-balls, have proved to be effective targets for use in field-testing developmental radar transmitters and receivers. Recently, Army radarmen reportedly tracked 49 out of 50 balls fired at ranges from 5-5000 ft. from the tracking systems.

World's Largest Bubble Chamber Built

The world's largest bubble chamber was completed recently at the Rutherford Lab of Britain's National Institute for Research into Nuclear Science, U.K.A.E.A., Harwell. The equipment has been tested and will now be dismantled and shipped to Geneva, where it will be used initially with the 25,000-Mev proton synchroton of CERN. By the middle of 1964 it will be returned to Harwell for a long program of experiments with the new 7000 Mev proton synchroton, Nimrod, which is being built there this summer. The chamber holds 60 gallons of liquid hydrogen at 27°R and particle tracks are photographed by three separate cameras to provide a stereoscopic record.

PROPULSION

Apollo Escape Pitch Controlled

If the *Apollo* launch escape motor ever has to be fired in flight, MISSILES AND ROCKETS has learned, it will pull the three-man Command Module away from the final launch vehicle stage in an arcing trajectory, about 4000 ft. above the vehicle and a similar slant distance. Original escape motor concept at Lockheed Propulsion called for different nozzles and a thrust-vector-control system to maintain module attitude during escape. This approach was changed last summer to a pitch-control system in the small adapter section forward of the escape motor. A small solid-propellant motor in this section is ignited at the same time the escape motor and separation bolts fire. Thrust from this motor controls pitch angle and resulting arc-type trajectory.

UTC to Study Beryllium Combustion

United Technology Center will study laboratory-scale combustion phenomena of beryllium under a $48,090 contract with the Air Force. The research will include the burning of aluminum and beryllium vapor in various oxidizing gases. The study ends in December, 1963.

ADVANCED MATERIALS

Ideal Iron At Materials Research Corp.

Alpha iron single crystals several inches in length have been prepared by researchers at Materials Research Corp. The single crystals reach the highest purity ever reported, based on resistivity ratios. The "ideal" iron is made by electron-beam zone refining of the starting material and subsequent conversion to the single crystal form by straining and heat treatment. Work at the firm is sponsored by the AEC. The major program objective of the pure-iron project includes further development of techniques for crystal preparation resulting in reproducible structure and properties.

AFOSR January Grants Total $4.5 Million

Basic research grants and contracts totalling more than $4.5 million were let to 48 universities and 14 research firms in the U. S. and Europe during January, 1963, by the Air Force Office of Scientific Research. This brings the Fiscal 1963 total to more than $16 million. The grants and contracts are generally based on unsolicited proposals and the originality of the proposed research is the determining factor in selection.

SPACE MEDICINE

Space Radiation Being Mapped

NASA's Goddard Space Flight Center is in the process of preparing a "Space Radiation Map" with the Office of Space Sciences. Using all currently available data, it will provide a single, obtainable source for all spacecraft design information on the space radiation environment and its time variations. In addition, the agency will identify problem areas for further study. Freeze date for shielding design of *Apollo* sometime this calendar year is making the need for this information critical.

Bendix Seeks LEM Landing Contract

Thoroughly researched impact system is said capable of handling most adverse lunar conditions foreseen

by John F. Judge

SOUTH BEND, IND.—A major aircraft landing gear producer is pushing hard to win the contract for the multi-million-dollar Lunar Excursion Module touchdown system.

Bendix Products Aerospace Division is basing its bid on a thoroughly researched impact system capable of handling the most adverse lunar landing conditions while comprising only 2.5% of the total LEM weight.

The four-legged, crushable-materials energy attenuation system is the outgrowth of intensive computer studies and experimental analysis based on a maximum stability-to-weight design criterion.

Basic concept studies covered every general approach to the problem—pogo-type shock attenuation with stabilizing cable darts, body-contained shock attenuators with stabilizing arms, ground-effect alignment, and full annular crushable gear as well as multiple point contact or leg-type gears.

• **Four legs best**—Parametric trade-off studies resulted in selection of the multiple-point contact approach; both digital and analog computer analysis boiled the multitude of configurations involving 3-4-5-6-8 legs down to a handful of optimum concepts.

Bendix investigators found excellent correlation between their mathematical analysis models and actual dynamic drop-test data. Company spokesmen now flatly state that a four-legged landing gear system will be superior to a five-legged system on a weight versus stability basis—given the LEM vehicle performance specifications and NASA's suggested lunar soil model.

Two full-scale primary strut members incorporating the crushable-material shock attenuation system are now being fabricated. These will be tested under static, vibratory and functional stroke conditions. This operation is expected to confirm the structural analysis approach and a planned fabrication technique involving epoxy adhesive bonding at the structural joints.

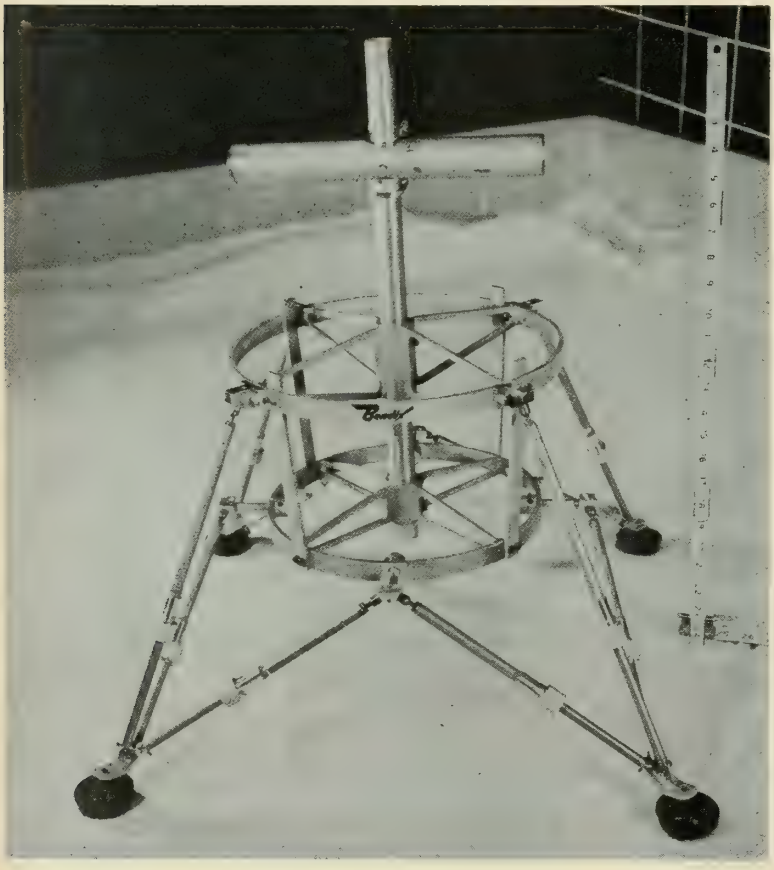
Under the direction of R. W. Smith, chief engineer, Space Structure Mechanics, the Bendix team is poised to push farther into more detailed general studies in the development of crushable-material shock attenuators. This effort will concentrate on three energy-absorption capsule configurations with varying strength levels and honeycomb cell orientation.

Energy-absorption efficiency, load-onset rates and rebound characteristics will be covered, together with extreme (−250° to 300°F) temperature effects.

Both government and industry sources say the Bendix effort is by far the most advanced work in this area.

The LEM touchdown conditions governed the landing gear design approach. In general, these conditions are as follows:

Surface Slope	0° to 5°
Vehicle Attitude with Respect to Local Vertical	0° to 5° any direction
Vertical Pitch Rate about the C.G.	0 to 0.1 radian/sec. any direction



THE LEM 4-LEG, tripodal impact system model rests on the NASA-suggested lunar surface. Bendix engineers did not incorporate the extremely small honeycomb energy-absorption capsules into such a model, since little or no valid information would result. Instead, the energy-absorption factor was simulated in the struts by teflon friction clamps. Care was taken to select clamp/bearing surfaces with a minimum difference in static-to-dynamic friction.

Horizontal velocity of C.G.	0 to 5 fps in any direction
Vertical velocity of C.G.	0 to 10 fps
Friction Coefficient	0 to infinity

The landing gear system employs four legs—each a simple tripod configuration—and all members are capable of shock-attenuating stroke. A gear-deployment mechanism is housed in each right-hand lower strut.

This mechanism holds the gear in the stowed position until deployment. A gas-operated actuator deploys the strut, rotating the legs about an axis through the upper strut and lefthand lower strut vehicle-attach points. The deployment mechanism locks the gear in the deployed position.

This skewed-axis deployment uses only one actuator on each of the four legs and permits a shorter LEM-to-launch vehicle adapter section than would be possible with purely radial deployment.

The deployment energy is extremely small—almost equivalent to the friction resistance of the Teflon-coated bearing surfaces involved. In addition, Bendix has designed the system so that it may be manually released and the introduction of a slow roll into the vehicle will extend and lock the landing gear.

• **Post-arrestment stabilization**—An actuator and latch mechanism is provided in each upper strut to extend the leg to the lunar surface in case all are not fully implanted after touchdown. This is not a levelling device but rather another stability factor, preventing rocking of the LEM. Extension occurs after the explosive release of a marmon clamp and the pressurization of the actuator by a pyrotechnic gas generator. The extended leg is then locked by a simple ball-and-ramp mechanism.

Bendix engineers evaluated a host of energy-absorption and shock-attenuation devices. Most of these involved the controlled deformation of solid or plastic materials—performing a kinetic energy conversion of work into heat. Compression of gas or fluids, and the metering of fluids such as those in conventional shock absorbers also were studied.

Potential advantages can be shown for every method, but the Bendix comparative study revealed inherent weaknesses in many of the systems—especially where reliability is closely related to simplicity and freedom from critical design and operating factors.

Those impact systems using pressurized gas or fluids depend on seal reliability as well as basic mechanism reliability. These must also be considered in the light of potential meteoroid impact.

Concepts involving the mechanical deformation of solids by machining, shearing, stretching or compressing appear less vulnerable to space-environmental effects. But even here Bendix researchers found that many depend on close tolerances, lubrication, and alignment. Thus, the choice of crushable materials in capsule form looked attractive.

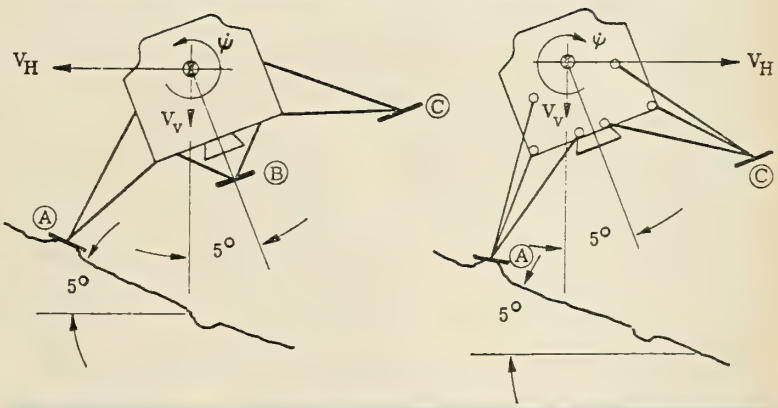
Bendix engineers will not argue about the efficiency of other means. They say the other approaches just are not that more efficient than the crushable route to warrant the effort needed to avoid their pitfalls.

In determining which crushable material should be used, Bendix zeroed in on aluminum honeycomb and balsa wood. The latter material has been all but dropped from consideration in current plans. While it is more efficient in terms of energy absorption, it raises difficult problems in uniformity and splintering, and there are questions as to its elevated temperature behavior in vacuum.

Bendix considered that the available data on crushable materials was insufficient, since most of the test work had been performed in atmosphere and with small samples. Sizable specimens were fabricated, and these capsules were crushed under vacuum to eliminate the effect of the compression of cellular trapped air.

The rebound characteristic of aluminum honeycomb is inherently low and seems to be a function of core and cell orientation. The rebound factor arises when the impact energy results in a partial stroke—the uncrushed portion of the honeycomb capsule is deformed elastically, providing a certain degree of spring-back.

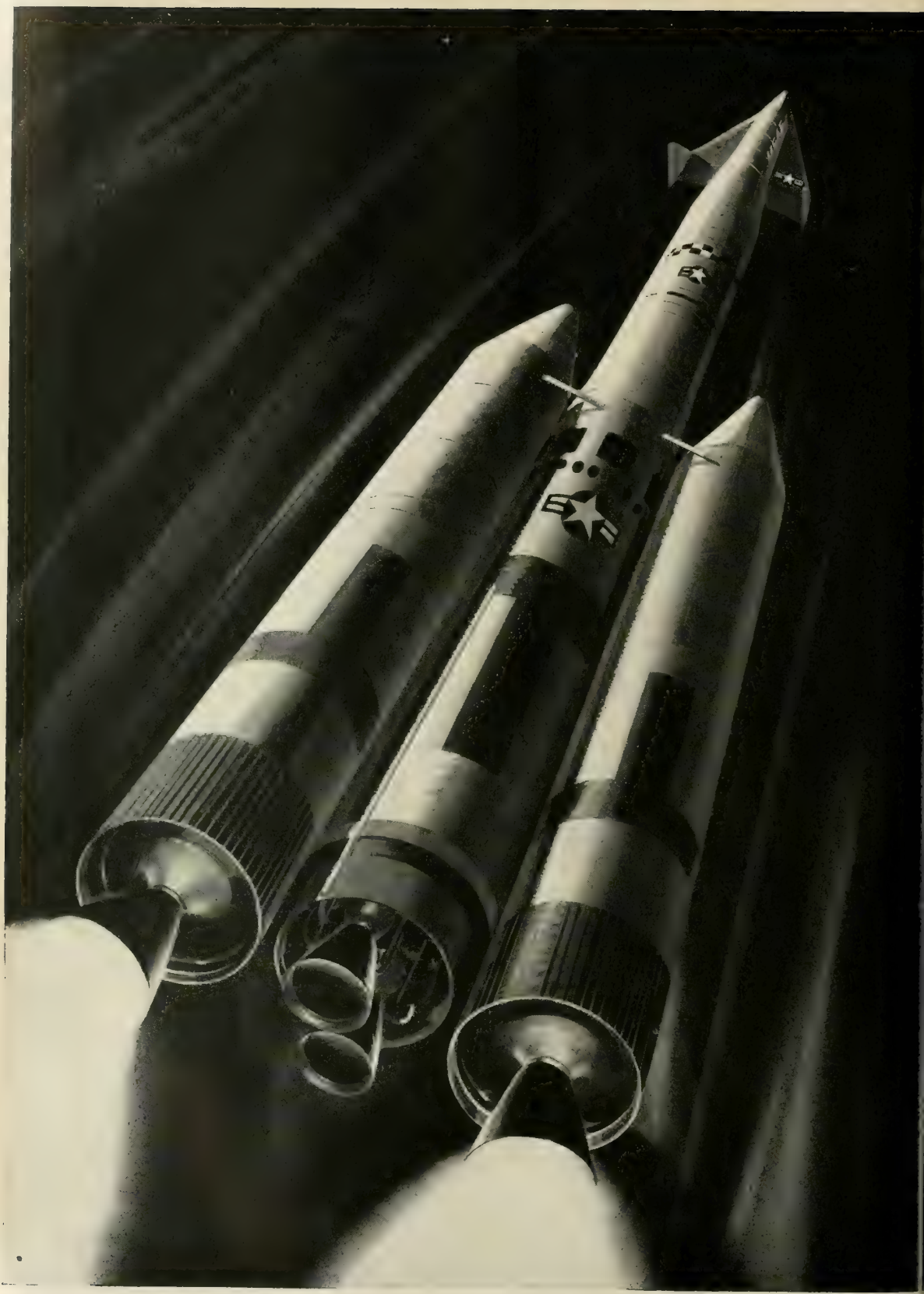
Onset-load considerations cause some concern in NASA circles, but Smith says the Bendix design can handle



CONDITION I: One-Two-One Impact | **CONDITION II: Two-Two Impact**

Critical Item	VELOCITY: VERTICAL Ft Sec	VELOCITY: HORIZONTAL Ft Sec	PITCH $\dot{\psi}$ Rad Sec	LEG FRICTION COEFFICIENTS μ_A	μ_B	μ_C	Condition
Critical Stroke Lower Strut	10	5	0.1	Non Sliding	0	0	I
Critical Stroke Upper Strut	10	5	0.1	0	0	0	I
Structural Interference Upper Gear—Frame	5	5	0.1	Non Sliding	0	0	I
Stability	Variable	5	0.1	Non Sliding	–	Non Sliding	II
Final Attitude of Vehicle	10	—5	—0.1	Non Sliding	—	0	II
	10	5	0.1	0	Non Sliding	0	I

BENDIX's "most adverse" design conditions are illustrated here within the design and performance specifications of the LEM itself. Condition I illustrates the pitched attitude landing on one leg uphill and represents the maximum energy-absorption event. Condition II, the simultaneous impact of two legs on a pitched attitude, downhill landing represents the worst touchdown event from the standpoint of vehicle stability. The landing gear design is compatible with these two maximum adverse landing conditions. The maximum energy capacity of each gear leg is 22,500 ft.-lbs.



For USAF Titan III:
A Boost
of over 2,000,000 lbs.

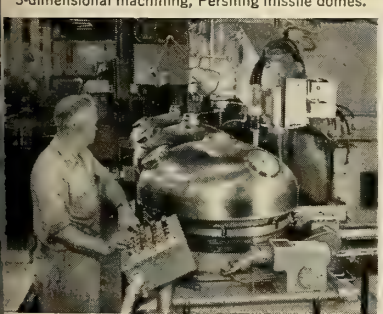
When the U. S. Air Force's Titan III thrusts toward space, its boost will come from two giant solid-propellant rockets. Together they will produce a push of better than two million pounds. For these huge twins, the Wright Aeronautical Division of Curtiss-Wright is fabricating solid-propellant motor cases ten feet in diameter and seventy-five feet tall—among the largest ever made. The contract for this project, awarded to Curtiss-Wright by the United Technology Center, a division of United Aircraft Corporation, highlights a space age capability at the Wright Aeronautical Division that has set "down-to-earth" records, too: 100% on schedule for the hundreds of motor cases already produced for the Minuteman and Pershing missiles.

In still other space age areas, Wright Aeronautical is developing main propulsion systems and vernier control systems for space applications, including subminiaturized attitude control devices... and developing advanced materials to withstand the ultra-hot blasts of future ultra-big boosters.

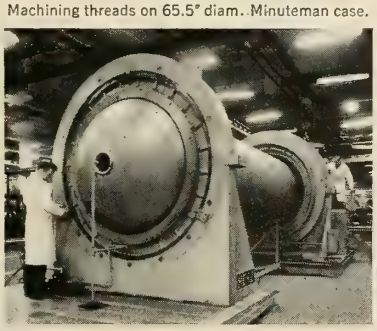
These programs are as striking for their overall diversity as for their individual significance. Quite obviously, they require technological abilities of great depth and breadth in metallurgy and heat transfer, propulsion and subminiaturization. This unusually comprehensive combination of capacities at Wright Aeronautical is available for *your* space age programs, too.

Information is available on request.

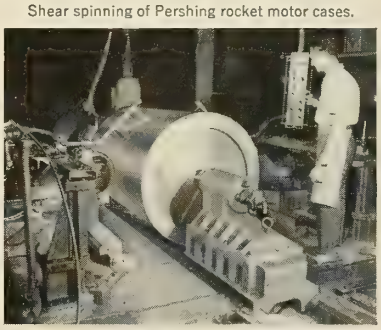
3-dimensional machining, Pershing missile domes.



Machining threads on 65.5" diam. Minuteman case.



Shear spinning of Pershing rocket motor cases.



Wright Aeronautical Division

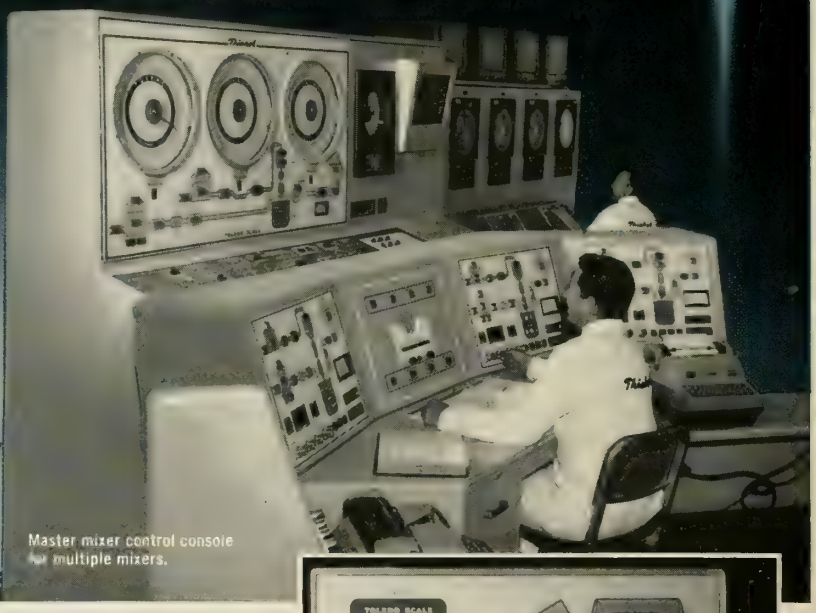
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Main and Passaic Streets Wood-Ridge, New Jersey

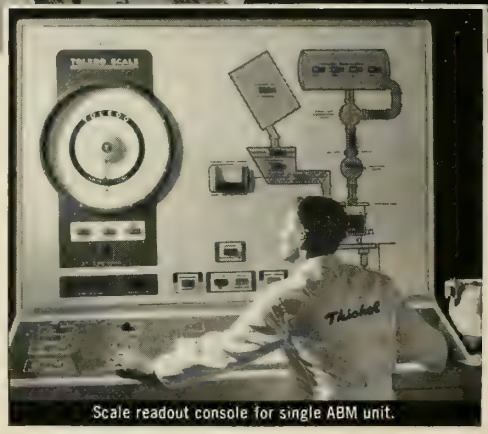
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Scale readout console for single ABM unit.

Thiokol's Automated Batch Mixing process has produced over 1 million pounds of very high energy propellant in less than a year.

With Air Force cooperation, Thiokol and Toledo Scales have developed an Automated Batch Mixing (ABM) system for propellant processing. In operation at Thiokol's Wasatch Division, ABM has turned out over 1 million pounds of high energy propellant. Recently completed Air Force Plant 78 is also fully equipped with this system, for production of Minuteman engines.

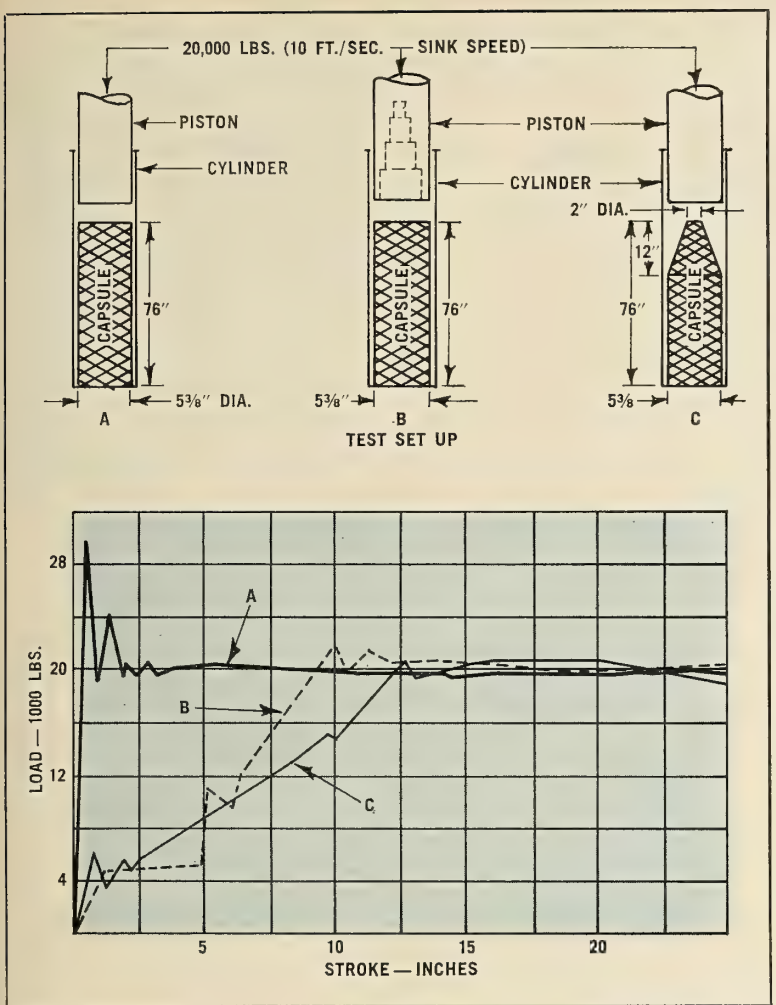
An electronically controlled method of materials handling, ABM eliminates the possibility of human error in the complex job of compounding and mixing propellant formulations. It also provides quality assurance throughout manufacturing on a recorded and "absolute" basis. Weighing precision is improved ten-fold. Over-all batch-to-batch variation is cut in half. Processing time decreases by 30%. Useable manufacturing capacity increases more than 20%.

ABM is a significant step for big booster production. After two years of development and demonstration, it is ready—and production proven at Thiokol.

Thiokol

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THREE DRAWINGS above the load/stroke chart illustrate the crushable energy-absorption test rig with three operating modes—flat capsule (A), tapered piston (B) and tapered capsule (C). Introduction of taper lessens the onset or immediate load build-up. Bendix uses a vacuum of $2x10^{-2}$ mm. Hg within the test work area. In the energy-absorption curves illustrated, Bendix engineers admit curve C is ridiculous from an energy absorption standpoint, but the entire set shows the limits of the crushable material.

this—even with untapered honeycomb capsules. Investigations are continuing.

In addition, Smith takes the position that the onset rate on the capsule will have little effect on the astronauts, inasmuch as there are a number of shock-attenuation functions operating between the crew and the impact point.

• **Gear configuration**—Each of the four legs consists of three energy-absorbing struts mounted so as to form an inverted tripod. Each strut of the tripod leg is connected to the vehicle through a spherical (uniball) bearing.

Footpad stability is provided by attaching the upper strut through a spherical bearing—one lower strut through a clevis joint permitting limited rotation in an essentially horizontal plane, and the other strut through a rigid coupling.

This footpad-to-strut joint arrangement is designed to carry the following moments generated by unsymmetrical loading on the foot pad:

—Moments about an axis parallel to the ground and normal to a line connecting pad and vehicle longitudinal axis are divided between both lower struts.

—Moments about a vertical axis are carried by the rigidly attached strut.

—Moments about the remaining horizontal axis are handled equally by the two lower struts.

The angle between any of the struts can change as required by the stroking of the struts.

To satisfy the LEM design and performance criteria, the struts are designed to stroke only in compression. Vertical movement of the vehicle without any footpad sliding causes all struts to stroke, producing the highest acceleration of the vehicle's center of gravity.

Horizontal movement of the footpad towards the vehicle center line causes the stroking of all three struts of that leg. Horizontal movement of the footpad in a direction normal to a footpad-to-vehicle radial line causes tension loads to be generated in the leading lower strut and compression loads in the trailing lower and upper struts.

Horizontal forces acting to move the footpad radially outward from the vehicle centerline produce tension loads in both lower struts, forcing the upper strut to compress.

Vertical descent of the vehicle onto an essentially frictionless surface causes the footpad to slide, makes the lower struts rotate upward under a tension load and produces compression loads in the upper strut.

The footpad itself is composed of three principal elements. The lower section consists of pie-shaped wedges of aluminum honeycomb forming a complete cylindrical section. The bottom is pre-crushed and smoothed to form a sole plate for better abrasion resistance. This section is 4 in. thick, allowing a 3-in. crushing stroke during touchdown or permitting deformation and load absorption in striking protuberances from any side.

The upper section of the footpad has a 1-in. layer of pre-crushed honeycomb to distribute loads from the forged aluminum strut-attachment fitting.

The upper struts consist of outer and inner cylinders and the energy absorption capsule. The outer cylinder is a thin shell of aluminum alloy. It is bonded to the strut extension actuator at its upper end and provided with a Teflon-lined bearing to accept the piston at its lower end.

The aluminum honeycomb energy absorber is bonded to a bulkhead in the outer cylinder at one end and to the piston at the other end. This bonding procedure prevents rebound of the inner cylinder during touchdown. The inner cylinder is again a thin shell aluminum alloy tube with a piston head at its upper end.

The lower strut stroking mechanisms are similar except that one has the deployment actuator and both have what Bendix calls a tension fuse. This tension fuse is a safety factor design input to prevent high loads on the upper-strut hard-point attachment during a crash landing. Such forces might jam the escape vehicle.

In the event of a crash landing, where the vertical force of the vehicle

BIG ADVANCES

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The nuclear powered submarine is one of the most complex weapons systems yet devised. To the exacting requirements of building a ship to operate safely, quietly and efficiently at high speeds in the rigorous environment of *inner space*—as foreign to man as interplanetary regions and in many aspects still as unexplored—are added the problems of nuclear propulsion plant engineering, missile systems operation, and life support conditions for *scores* of men.

It is no wonder, then, that Engineers from many disciplines work together—and in so doing, broaden their professional scope—at Electric Boat, birthplace of the nuclear powered submarine.

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STATISTICAL SIGNAL ANALYSIS
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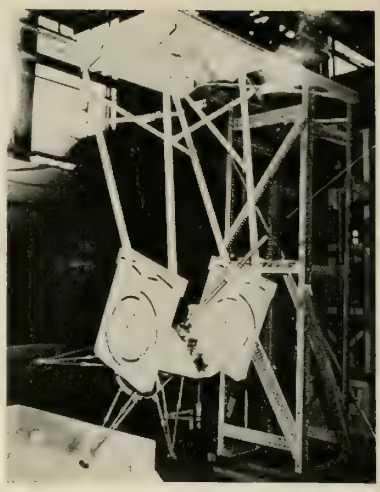
- Design of special instrumentation for measurement of acoustic & vibration data
- Design and installation of interior communication systems, navigation systems, ship control systems, depth control systems, steering & diving devices
- Application & systems engineering of radio, radar, sonar and countermeasures systems & components
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Your inquiries are invited.
Please address Mr. James P. O'Brien.

GENERAL DYNAMICS | ELECTRIC BOAT

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LANDING GEAR model is poised for pitched-attitude drop test in the Bendix Drop-Test apparatus.

is sufficient to cause vertical footpad motion beyond that of the fully stroked upper strut, the tension fuse allows lower strut extension in an energy-absorbing manner.

The lower struts must stretch if the fuse is to operate. The fuse itself consists of a honeycomb energy absorber-piston arrangement so positioned that the piston crushes this capsule in the direction of the footpad. Thus the fuse effect is the compression of an aluminum honeycomb capsule while the strut itself is under a tension load.

This factor provides stability to the LEM while the lower vehicle body is being crushed during an impact higher than the design criteria.

In the Bendix analysis, the upper strut length is 147.54 in., with a stroking distance of 40.0 in. at a minimum force of 3800 lbs. The lower struts are 119.8 in. long, with a 40-in. stroke. These have a minimum stroke force of 1300 lbs. in compression and 6338 lbs. in tension.

The gear itself will be subjected to launch vibration, the space environment and hot gas exhaust from the descent rocket firing. Smith is not worried about radiation effects, but thermal considerations have led to investigation and selection of insulation systems on the gear.

Bendix is attempting to define the market area in space vehicle landing gear—and this includes Earth touchdown. The firm supplies the *Dyna-Soar (X-20)* nose wheel skid. The Division believes that both the hardware and engineering must be sold as a package to make any such operation interesting in a business sense.

Each landing system is a special case, and only very general approach routes are common to any number of specific vehicle touchdown systems. ■

Radar Systems Guard ICBM Bases

Sylvania's security 'blankets' employ bistatic Doppler technique to produce electromagnetic radiation field

by Robert Lindsey

MOUNTAIN VIEW, CALIF.—Sylvania Electronic Systems has delivered the first model of two new types of radar security systems which have been selected to guard virtually all of this nation's ICBM bases.

The systems use bistatic Doppler radar to blanket missile silos and perimeters around Launch Control Facilities (LCF) with a field of electromagnetic radiation. An alarm sounds at the intrusion of a human being. False alarm rate is reported to be low.

One system, described as an "invisible fence," generates a point-to-point field of radiation along narrow lines. This system will be used to protect perimeters around LCF above-ground missile storage areas.

The other system creates a three-dimensional "umbrella" or dome of radiation around silos.

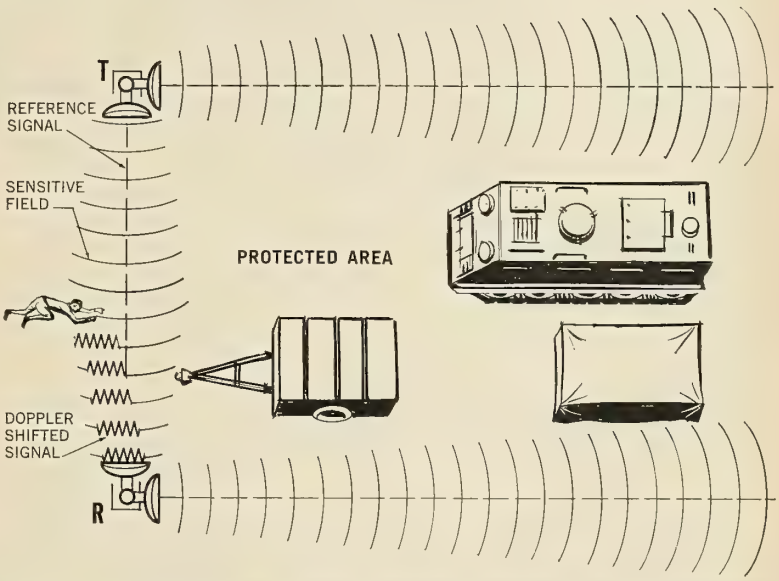
Both concepts have been adapted for *Minuteman, Atlas* and *Titan* bases, giving Sylvania a virtual monopoly on ICBM electronic sentry systems only two years after it entered the field.

Only silos at the *Minuteman* base at Malmstrom AFB, Mont., will not be guarded by the systems developed here. Malmstrom's silo anti-intrusion system was made by Boeing. Sylvania won the follow-on program for subsequent *Minuteman* bases in competition with Boeing. Sylvania was recently asked to provide LCF systems at Malmstrom, and the first models have been delivered.

The program has been funded through the first five *Minuteman* wings.

Melvin E. Lowe, director of Sylvania's Reconnaissance Systems Laboratories here, where the work is being done, said the basic radar anti-intrusion concept was developed in a classified program for the Air Force's Rome Air Development Center.

It was adapted for protecting missile sites after USAF Ballistic Systems Division sought a system which would be effective for monitoring the dispersed, unattended *Minuteman* silos, but would have a low false alarm rate.



SKETCH ILLUSTRATES how intrusion is detected in perimeter security systems using Doppler principle. Intrusion creates Doppler shift, which is immediately analyzed by the equipment. Equipment "decides" that a human intrusion has occurred, and triggers alarm.

Adaption of the concept for *Titan* and *Atlas* sites followed its successful evaluation for the *Minuteman* program. The Army is now evaluating one of the systems for possible use in protecting *Nike-Hercules* launchers.

• **Operation**—Lowe said there are about six basic models. Although he declined to discuss details of specific systems because of security considerations, he described their operation in general terms:

Both systems use a cw transmitter to radiate electromagnetic radar waves from one side of the area to be protected to a receiver located at the other side.

In the perimeter system a relatively narrow beam is transmitted, so parabolic antennas are utilized. For the volumetric system, the beam is considerably wider. Corner reflectors are used.

In use, the transmitter is in continuous operation and the signal received by the receiver is constant. But if an object enters the field, frequency and strength of the signal received is changed by reflections from the object.

Any Doppler shift in the signal is identified by the receiver. (Size of the object determines the strength of the signal and its speed determines the Doppler shift.)

Although primed to detect any Doppler shift, the system is designed to have a very high probability of detection against human intruders while maintaining high discrimination against nuisance alarms from such objects as birds and small animals.

The height of the "fence" created by the perimeter system is classified, but it is believed to be considerably taller than a man; in other words, according to one engineer, "you couldn't pole vault over it."

Coverage of the volumetric system

extends to about the same height, but spans over a three-dimensional area. It offers protection in the unlikely, but possible, chance that a parachutist would try to by-pass fences and drop down atop a silo lid.

As he entered the radiation field, radar waves would bounce off him and be detected by the receiver. More than one receiver is used in some of the volumetric systems.

• **Invulnerable**—Lowe said the anti-intrusion systems are "self-protecting." Radiation extends around each transmitter and receiver to detect intruders trying to knock them out of commission.

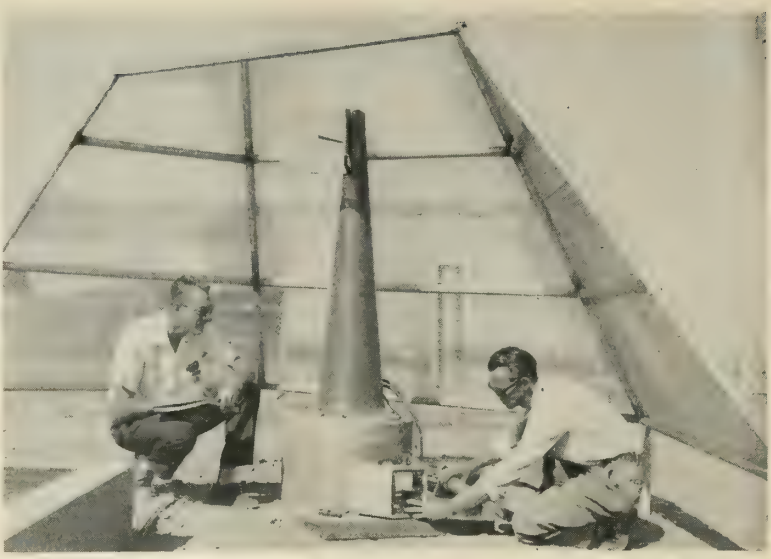
He added that the systems are "jam-proof." While one team of engineers here has been working to develop the systems, he said, an independent team has been trying to crack them. But "we don't know of any way of defeating them at this time," he said.

Each antenna is covered by a radome. To assure that the systems continue to work in case of a failure in the primary power system, each transmitter and receiver has its own battery, which switches on automatically at loss of power.

If efforts are made to deceive or jam the system, alarms are sounded at the LCF. Similarly, component failures sound alarms.

Officers at the LCF monitor all of the missile silos under their jurisdiction. Either a bell or flashing light is used at the LCF console to signal intrusion.

The systems will be produced at Sylvania's Santa Cruz, Calif., plant, engineering and prototype production here. Lowe said the engineering program is continuing, with emphasis on reliability and further decreasing false alarm rate. ■



SYLVANIA engineer Clay Loftin, left, and technician John Weller check electronic security system used to protect Minuteman silos from possible human intrusion.

Trailers by Dorsey for *Electronic Equipment*

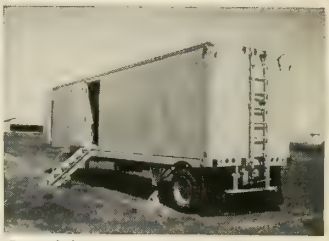
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This insulated, air-conditioned trailer was built by Dorsey for General Electric Company's Missile and Space Vehicle Department to house checkout equipment for the Nimbus space craft.



Dorsey built this special trailer for Raytheon Company to house the Army's new AN-MPS-34 mobile weather radar.



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Unique Monopulse Antenna Developed

Log-periodic dipole units rapidly acquire and lock onto any signal in the 30-300-mc range above Earth's horizon

by Charles D. LaFond

DALLAS—A pyramidal array of log-periodic dipole antennas has been developed by Collins Radio for use in the 30-300-mc range as a satellite tracking antenna.

Originally designed in a company-funded research project by Collins' Space Systems & Antenna Division here, the unique monopulse system was subsequently funded through R&D and limited production by the government.

Contract details, including the identity of awarding agency, are highly classified; it is believed, however, that the project has been co-sponsored by Department of Defense and other government intelligence agencies. (Several of the satellite monitors are reportedly now in operation in remote areas of the globe, and the frequency range covered includes that used by Soviet satellites.)

The 2400-lb. array has been used to accurately track and monitor near-Earth satellites at a variety of orbital altitudes, Collins says. Developers claim the system can rapidly acquire and lock on any signal in its 30-300-mc operating frequency range emanating from any object passing above the Earth's horizon.

Principal limitation of their new array, say Collins engineers, is its relatively low gain—nominally 12 db.

• **Massive maze**—Looking much like an erector set gone wrong, the massive antenna (excluding pedestal) measures 25 ft. in length from counterbalance to the array extremities and is approximately 18 ft. wide by 18 ft. deep.

Booms, elements, and the control area all are fabricated of aluminum. The antenna proper weighs roughly 500 lbs., the control-equipment section about 700 lbs.

The all-steel counterbalance section weighs approximately 1200 lbs.

• **Design characteristics**—Individually, the log-periodic antennas are frequency-independent over the 10:1 band. Also, developers point out, they differ very little from standard log-periodic antenna designs.

To obtain frequency independence of the monopulse characteristics, the log-periodic antennas are tilted toward each other to maintain a constant spacing in wavelengths between the phase centers of the different elements. Collins says this approach is taken because the phase center of an individual log-periodic antenna moves along its axis as the frequency is changed.



COLLINS RADIO'S Merton Bushong, antenna designer, inspects unit before new trackings are made. Collins developed the antenna to monitor low-level Earth satellites.

Each array element actually consists of two linearly-polarized, log-periodic, dipole antennas. These are positioned orthogonally with a common axis. It was found that this configuration permits the reception of two linear polarizations (vertical and horizontal). Further, by inserting a 90° phase shift in one antenna (depending upon the sense desired), circular polarization can be obtained.

Outputs of the four array elements (eight outputs) are switched simultaneously by a coaxial switching network provided for remote selection of the desired polarization. The switching network is divided into three sections, one for each of three sub-bands, because of the difficulty of maintaining a constant 90° phase shift over a 10:1 band. Maximum ellipticity over the 10:1 band is less than 3 db, according to Collins.

It was also found necessary to design a three-section monopulse comparator network, because of the difficulty of obtaining broadband hybrids. Each section (one for each sub-band) consists of four hybrids in the conventional "sum and difference" configuration. The null depths of the difference patterns over the 10:1 band are more than 30 db.

Sum-channel halfpower beamwidths, developers say, are of the order of 30° to 35°. Cross-coupling between elements is down more than 20 db, and the voltage standing wave ratio of each element is less than 1.8:1 over the band. ■

New Career Positions at NASA

Outstanding Opportunities Available Immediately At NASA Centers in Maryland, Texas, Alabama and Ohio

The career positions outlined below bear a direct and significant relationship to the nation's space effort. Respondents should have a BS or advanced degree from an accredited college or university and appropriate experience. Please send your inquiry to the Personnel Officer of the individual NASA center, as indicated below.

NASA GODDARD SPACE FLIGHT CENTER

Dept. ND-2, Greenbelt, Maryland (Suburb of Washington, D. C.)

Satellite Tracking

Various positions at beginning through senior level involving research, design and development of optical and electronic devices and systems. Also, openings in systems analysis and evaluation and in management of overseas tracking stations.

Communications & Data Acquisition Program Management

Technical management for development of satellite communication and data handling subsystems. Positions require laboratory experience in design of miniaturized electronic flight hardware.

Systems Analysis

For evaluation and systems design of complex data processing facility utilizing special purpose telemetry reduction equipment and large scale digital computers. Background in computer systems design, digital computer programming or data analysis.

Spacecraft Heat & Light Control

Development of thermal analysis techniques; thermal design of spacecraft; design and development of passive and active temperature control systems; research on coatings with precise optical properties; development of techniques for rapid and reliable measurement of optical properties in infra-red, visible and ultra-violet. Involves consideration of effects of the space environment, including vacuum, ultra-violet irradiation, electron and proton bombardment and thermal stress.

Electronic Flight & Support Systems

Design, coordination and integration of all electronic subsystems for satellites. Beginning through senior level openings.

Space Vehicle Project Management

Rocket launching, analysis and evaluation of rocket vehicle flight performance. Includes development of techniques for acquiring and evaluating data, design and modification of rockets for specific payload requirements, trajectory studies, stress and vibration analysis and technical management of rocket vehicles. Beginning through senior level openings.

Flight Systems Test

Test and evaluation in areas of stress, magnetics and vibration. Beginning through senior level openings.

Project Management, Launch Systems

Vehicle and satellite systems preparation, test and checkout, spacecraft-vehicle integration, trajectory analysis and vehicle flight performance, and overall project management for launch operations.

NASA MANNED SPACECRAFT CENTER

Dept. ND-2, Houston, Texas

Space Sciences

Development of manned spacecraft mission including simulation of space environment for projects Gemini and Apollo. Intermediate and senior level openings requiring experience in Geodesy, Astronomy, Astro-Science or Geophysics.

Propulsion & Power

Intermediate and senior level openings requiring experience in liquid and/or solid propulsion, with emphasis on nozzle design, flow patterns, gas dynamics and spacecraft design.

Fluid & Flight Mechanics

Thermo dynamics, heat transfer, thermal control, fluid flow, landing systems (parawing, rotor systems, parachute) and spacecraft components. Intermediate and senior level openings.

Data Acquisition Systems

Data acquisition, computer operations, computer programming, and control and guidance systems. Intermediate and senior level openings.

Spacecraft Communications & Instrumentation

Detailed functional analyses of systems installed in both manned spacecraft and booster stages to determine operational aspects of crew-to-earth communication links, problem areas, sources and effects of data system errors, etc.

Spacecraft Guidance & Control

Analyses of manned spacecraft guidance, navigation, stabilization and control systems to determine operating modes for all mission phases, sources and effects of system errors, etc. Provide liaison between flight crews and applicable project office. Monitor developments.

Spacecraft Thermo Systems

Analyses of manned spacecraft environmental control systems to determine operating modes, optimum controls and displays, manual vs. automatic allocation, and operating safety margins. Provide crew training on systems. Intermediate and senior level openings.

Power Systems

Analyses of spacecraft power systems to establish operating and failure modes, automatic vs. manual allocation, and optimum controls and displays for the mission. Provide flight crew training on systems. Intermediate and senior level openings.

NASA LEWIS RESEARCH CENTER

Dept. ND-2, Cleveland, Ohio

Propulsion Components & Systems

Experience with cryogenic tanks and valves, turbo-machinery, dynamic controls, thrust chambers, gas generators, heat exchangers, systems analysis and systems testing. Research on heat transfer, lubrication and bearings, fundamental flow processes, tank pressurization and turbopumps. Intermediate and senior level openings.

Reliability & Quality Assurance

Analysis and appraisal of specific hardware and systems designs. Develop standards to judge reliability and performance, together with appropriate test plans for materials and equipment rating. Establish procedures and systems to assure conformance of hardware and equipment to specifications. Failure analysis of defective components and systems.

Facilities Engineering

Design and construction of large scale engine test and space environment facilities; analyze test requirements; develop test chambers, support systems, handling facilities, operating techniques; instrumentation and control systems for specific tests. Beginning to senior level openings.

Project Development Engineering

Engineering analysis of project requirements; develop schedules and test plans; analyze test results, contractor reports, project review data; liaison with contract representatives and other technical management responsibilities.

Mission Analysis & Application

Analysis of mission requirements in terms of flight paths, orbits, payloads, propulsion, control, and guidance; configuration and matching studies of vehicles, boosters, and their combinations; energy management studies, studies related to orbital rendezvous and landings on planetary bodies. Beginning to senior level openings.

Vehicle Structures

Conceive and design vehicles to meet particular space flight requirements. Includes structural analysis, size and weight studies, systems layout, power and propulsion requirements, materials selection.

Ground Support Equipment

Design and development of ground support systems for checkout and launching of specific payloads and stages.

Nuclear Propulsion & Power Systems

Scientists and engineers skilled in Nuclear Reactor Technology, radiation and shielding, materials deterioration and nuclear rocket heat transfer studies. Other work specialties concerned with the operation and performance of experiments in a 60 megawatt experimental test reactor at Plum Brook Station at Sandusky, Ohio. Intermediate and senior level openings.

Space Power Generation

Mechanical fuel cell and solar cell systems. Research Engineers and Physicists skilled in liquid metals technology, magneto-hydrodynamics, refractory coatings, turbomachinery, fluid dynamics and heat transfer, electric generators, power conditioning, thermionics, physical metallurgy and fabrication, environmental testing, system controls. Research on direct conversion of thermal, solar or nuclear energy to electrical energy. Involves semiconductor and plasma energy conversion devices. Beginning to senior level openings.

Gas Turbine R&D

Research and development on turbine and pump components for rocket propulsion and space power systems. Research areas include: pumps for cryogenic propellants; liquid metal pumps and vapor turbines; gas turbines, axial, radial, and re-entry; axial-flow compressors; alkali metal test facilities.

NASA MARSHALL SPACE FLIGHT CENTER

Dept. ND-2, Huntsville, Alabama

Automated Control Systems

Research in Theoretical Physics, Aerodynamics and Mathematics including establishing trajectories for space vehicles and evaluating flight mechanical parameters. Includes pre-flight and post-flight evaluation of space vehicle or spacecraft flight and systems. Beginning and senior level openings.

Fluid & Flight Mechanics

Solution of advanced theoretical space vehicle and spacecraft problems in one or more of these areas: aerodynamics, flight mechanics, guidance and control and vehicle performance with emphasis on system conceptualization. Advanced degree preferred.

Space Sciences

Participate in space vehicle and spacecraft theoretical atmospheric physics studies in one or more of these areas: wind turbulence, wind shear, model atmosphere and terrestrial and space environmental conditions.

Flight Mechanics

Theoretical research studies for space vehicle in one or more of these areas: optimization of space orbits, sensitivity of orbits to celestial influence, development of analytical formulation of space flight orbits, atmospheric re-entry flights, stability and control of rigid bodies, guidance control systems and flutter and vibration.

Measurement & Control Systems

Solution of aerodynamic, electronic and instrumentation problems requiring analysis and evaluation of electronic measurement and instrumentation systems for experimental aerodynamic wind tunnels, space simulators and allied facilities.

Guidance & Control Systems

Several positions available. Control system component integration. Accelerometer, rate gyro and other control sensor performance testing and evaluation. Coordination of programming efforts for the Saturn automatic checkout system. Design, development, test and evaluation of flight control systems and/or associated components—electrical, mechanical, hydraulic or pneumatic. Senior and intermediate level openings.

NASA is an equal opportunity employer. All positions filled in accordance with Aerospace Technology Announcement 252-B.

Huge Antenna To Direct Spacecraft

Radiation Systems, Inc., to build four house-sized arrays for NASA's satellites, starting with EGO

by Charles D. LaFond

COMMAND SIGNALS to many future NASA space-exploration vehicles will be transmitted through a series of antennas of radically different design located around the Earth.

Although big enough to occupy an average 6-room house, each multi-element high-gain antenna costs roughly 1/10 that of a typical 85-ft.-dia. dish.

Under a recently announced $185,000 contract with Goddard Space Flight Center, Radiation Systems, Inc., will provide four antenna assemblies—each employing nine disc-on-rod elements.

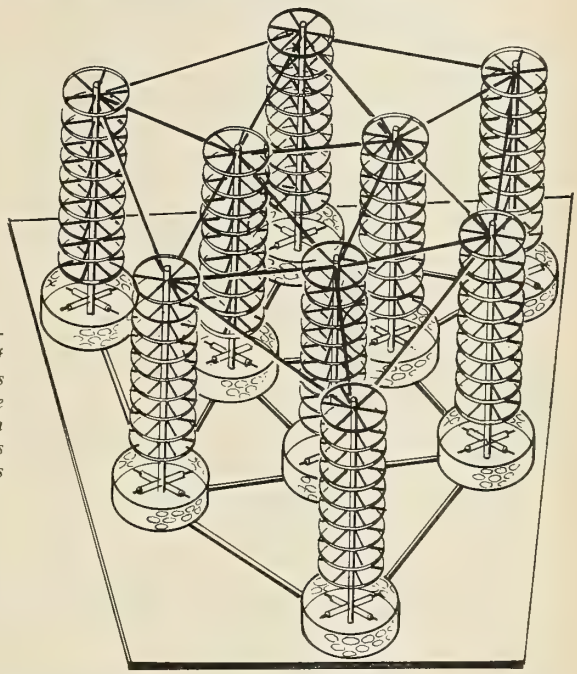
Each of the nine 25-ft long elements will be mounted and interconnected on a base measuring roughly 32 x 32 ft.

Operating in the 120-155 mc frequency range, the 7.5-kw transmitting antennas could yield 22-db min. gain.

A single element of the array, according to the Alexandria, Va. firm, is comprised of 10 discs fed at the rod base from a crossed dipole. Single elements are capable of providing a 12-db gain and have a 36° beamwidth.

A six-element experimental array, built to a 4.5:1 scale, is now under test and is expected to offer a similar system beamwidth.

At 120 mc, RSI estimates antenna absolute gain will be 22 db with a half-power beamwidth of 15°; the first side-lobe level at −31 db down, and the major side-lobe level at −26 db. At 150 mc, absolute gain is estimated at 26 db.



ARTIST'S CONCEPT of one of four new antennas for NASA's Satellite Network. High-gain systems will have bases 32 ft. square, elements 25 ft. long.

The system will provide left or right hand circular-polarization switching.

First antenna delivery under the NASA contract is due in May with the remaining units delivered one every three weeks.

The antennas will be installed at four existing stations in NASA's global tracking network. The new command antennas will be slaved to 85-ft. dishes at Fairbanks, Alaska, and Rosman, N.C., and to 40-ft. dishes at Quito, Equador, and Johannesburg, S. Africa.

The new command antennas will be employed first with highly eccentric scientific satellites, starting with *EGO*, the *Eccentric Orbiting Geophysical Observatory*, due for launch this year. ■

First Flight of Stratoscope II Called Success

JUBILANT Princeton and University of California scientists have hailed the *Stratoscope II* scan of Mars on March 1-2 as a success despite difficulties with the balloon-borne telescope.

Dr. Martin Schwarzschild of Princeton, director of the project, said "it was a miracle the system worked so near perfection the first time."

Dr. Harold Weaver of California said he believed data obtained from five scans of Mars would be useful. The bolometers did scan the infrared spectrum, he said, and obtained tracings appearing to confirm the presence of carbon dioxide.

The balloon was launched March 1 from the National Balloon Launch Center at Palestine, Tex. It achieved 79,000-ft. altitude before coming down by parachute near Pulaski, Tenn.

Data reception was delayed first when the television systems refused to activate. Repeated operation of the activation maneuver finally brought the system into action. Further delay occurred, however, in attempts to calibrate the instrument by scanning the Moon. It was finally calibrated by training it on Sirius. Then it made five scans of Mars.

Weaver said delicate analysis will be needed to arrive at precise estimates of the amounts of water vapor, methane and other elements in the Martian atmosphere.

The scientists said another infrared flight might be made this fall. The next time Mars will be near enough for another scan will be in 1965. The spectroscope scan will be trained on the dim, red giant stars.

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OPPORTUNITIES NOW EXIST to join PAN AM at the Cape in developing range systems hemispheric, global and celestial in scope—and share in the exceptional professional development implicit in these assignments.

Systems Engineers–EE's, Physicists & Mathematicians capable of assuming complete project responsibility for new range systems.

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Senior Engineers & Scientists—PhD's in Math, Physics, Celestial Mechanics, Astronomy or Electronics.

Experience in one or more of these areas: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, command guidance, underwater sound, timing, shipboard instrumentation.

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Dept. 56C-2, Pan American World Airways, Incorporated, P.O. Box 4336, Patrick Air Force Base, Florida.

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The Industry Week

NASA Patent Hearings Set

Another round will begin March 14 in the NASA-Congress tug-of-war regarding missile/space patent regulations and policies.

NASA Administrator James Webb will join Dr. Jerome Weisner, Presidential science advisor, at hearings of the Senate Small Business Committee's Monopoly Subcommittee.

Sen. Russell Long (D-La.), who is chairman, already has voiced strong criticism of the space agency for attempting to "distort" existing Space Act patent provisions. The government is required under these provisions to retain title to inventions perfected under agency-financed R&D. But waivers of this requirement are permitted when they can be shown to be in the public interest.

NASA claims that the act gives it authority to broaden present interpretation and applications of the waiver rule, but certain members of Congress have challenged the space agency's claim. Long has flatly denied that NASA has any such authority.

Weisner's testimony is expected in some quarters to reveal whether NASA's interpretation of the law has backing in the White House, sources on Capitol Hill said.

Signed, Sold, Merged

Dynamics Corp. of America will acquire the assets of International Electronic Research Corp., a Burbank, Calif., electronic component and instrument manufacturer. An estimated 100,000 shares of DCA preferred stock and 340,000 shares of DCA common stock—subject to adjustment downward for cash retentions by IERC—are expected to change hands in the deal. Details still have to be worked out, and the transaction must be approved by DCA's directors and IERC's shareholders before it becomes final. DCA has its home base in New York and—through its subsidiaries—produces specialized missile/space systems and equipment, communications gear and a variety of consumer and industrial products. Through three principal divisions and a subsidiary, IERC designs and produces heat-dissipating devices for tubes and transistors, precision electronic measuring devices and many other instruments and components. . . . *United-Carr Fastener Corp., maker of electronic components and fasteners, has bought Industrial Sections, Ltd., privately owned British producer of metal moldings. About $2.7 million was involved in the sale. UCF's British subsidiary, Carr Fastener Co., Ltd., will continue to operate as a separate division.* . . . Core Laboratories, Inc., international petroleum engineering and consulting firm, has acquired Electronic Management Systems, Inc., Dallas, Tex. G. B. Spaulding, former EMSI president, and T. W. Swafford, former EMSI vice president, will direct Core's program of diversification into the missile/space field. . . . *Hall-Sears, Inc., Houston, has become a wholly owned subsidiary of The Instrument Co. of Florida. Ernest M. Hall, Jr., former president of Hall-Sears, will serve as president of both ICF and Hall-Sears. ICF's primary product line includes timing systems, ballistic cameras, camera control gear and associated items.* . . . Baird-Atomic, Inc., Cambridge, Mass., and Allied Research Associates, Inc., Concord, Mass., will merge, pending approval by directors and stockholders of the two firms. Key management of the two companies has already merged, in effect, to handle details of consolidation. The union will include Allied's subsidiaries, Radiation Counter Laboratories, Aracon Laboratories, and Mark Systems, as well as Baird-Atomic's own Atomic Accessories, Inc., and its subsidiaries in Canada, West Germany and the Netherlands. . . . *Tamar Electronics, Inc., Anaheim, Calif., has purchased Stoddart Aircraft Radio, Inc., Los Angeles, and will operate it as a wholly owned subsidiary. Tamar is a partner company of Electro-Science Investors, Inc., Dallas, Tex. An undisclosed amount of cash was paid for the purchased firm to its sole stockholder, Richard Stoddart, who reported company sales over $3 million in fiscal 1962, and a current backlog of about $1.5 million.* . . . Control Data Corp. will acquire Bendix Corp.'s Computer Div., subject to approval by the directors of both firms. The deal involves the exchange of an undisclosed amount of Control Data stock, cash and "other considerations," spokesmen for the firms said, but total value involved in the transaction reportedly amounts to nearly $10 million. Control Data will take over the line of Bendix G15 and G20 computers, including operations, service and support of all current and future Bendix computer installations. The deal provides a long-term payment arrangement, a spokesman said.

Delta Project Group Honored

At NASA's special "*Delta* Day" ceremony at Cape Canaveral March 1, the space agency presented its Group Achievement Award to the *Delta* Project Group.

Dr. Homer Newell, director of NASA's Office of Space Sciences in Washington, D.C., and Harry Goett, director of the space agency's Goddard Space Flight Center, Greenbelt, Md., were among the group of top NASA officials taking part in the ceremonies.

Dr. Goett, who accepted the award for the *Delta* team, in turn presented a citation to Douglas Aircraft Co. for "outstanding performance" in the project.

OPPORTUNITIES
AT
NORTH AMERICAN AVIATION'S
SPACE AND INFORMATION SYSTEMS DIVISION

North American Aviation's Space and Information Systems Division is extending its capabilities into all realms of the aerospace technologies. Current programs include manned spacecraft, large booster systems, missile weapon systems, recovery systems and research in all of the aerospace sciences.

Two of the most challenging areas where immediate openings exist are in the Engineering Simulation group (manned spacecraft) and the Advanced Systems group which is concerned with all phases of systems engineering.

ENGINEERING SIMULATION • S&ID's Manned Spacecraft effort requires engineers and scientists to participate in a unique engineering simulation program. A BS degree in engineering, math, physics or a related field and several years experience in one of the following areas is required: simulation design • computer simulation • simulation evaluation • error analysis • integration • optical and visual systems • buffer design • computer circuits.

ADVANCED SYSTEMS • Projects under way include Advanced Systems investigations on manned and unmanned spacecraft, as well as the large chemical and nuclear launch vehicles of the future. Openings are available to engineers and scientists with 5 to 10 years experience in all phases of Systems Engineering including Conceptual Design, Program Requirements, and Project Engineering.

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SPACE & INFORMATION SYSTEMS DIVISION
North American Aviation

contracts and procurements

AWARDS

AIR FORCE

$21,500,000—**Thiokol Chemical Corp.**, Bristol, Pa., for production of Stage I *Minuteman* solid propellant rocket motors and related material. Work to be done at Brigham City, Utah.

$10,600,000—**Aerojet-General Corp.**, Azusa, Calif., for production of Stage II *Minuteman* solid propellant rocket motors (2 contracts).

$10,400,000—**Boeing Co.**, Seattle, for work on the *X-20 (Dyna-Soar)*.

$10,139,000—**Aerojet-General Corp.**, Azusa, Calif., for research and development of Stage II *Minuteman* motors.

$6,001,680—**Hercules Powder Co.**, Bacchus, Utah, for second-stage *Minuteman* motors.

$6,000,000—**International Telephone and Telegraph Co.**, New York City, for fabrication and delivery of electronic equipment.

$5,356,145—**General Motors Corp.**, Detroit, for production of guidance equipment and related material for *Titan II* missiles.

$3,375,570—**Litton Systems, Inc.**, Woodland Hills, Calif., for advanced aerospace flight-control systems.

$3,000,000—**Avco Corp.**, Wilmington, Mass., for work on *Minuteman* re-entry vehicles.

$3,000,000—**Hercules Powder Co.**, Wilmington, Del., for research and development of improved Stage III *Minuteman* motors. Work to be done at Bacchus, Utah.

$2,650,000—**Aerojet-General Corp.**, Azusa, Calif., for research and development of liquid rocket engines.

$2,400,000—**North American Aviation, Inc.**, Anaheim, Calif., for research and development on *Minuteman* guidance and control systems.

$2,000,000—**General Dynamic Corp.**, San Diego, Calif., for launch and related services at Point Arguello complex.

$1,835,066—**General Electric Co.**, New York City, for work on an air weapons control system at Syracuse, N. Y.

$1,704,901—**Electro-Mechanical Research, Inc.**, Sarasota, Fla., for an interpolating and display subsystem for Missile Test Center, Patrick Air Force Base, Fla.

$1,659,000—**Hazeltine Corp.**, Little Neck, N. Y., for electronics equipment.

$1,600,000—**Sylvania Electric Products, Inc.**, New York City, for research and development of a *Minuteman* security subsystem. Work to be done at Mountain View, Calif.

$1,554,997—**General Motors Corp., Detroit,** for work on *Titan II* guidance systems. Work to be done at Milwaukee.

$1,550,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on space subsystems (supplemental contract).

$1,525,679—**General Dynamic Corp.**, San Diego, for *Atlas* missiles.

$1,478,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., for communication equipment and services to be used in SAC's Airborne Command Post program (4 contracts).

$1,067,500—**Western Electric Co.**, New York City, for space guidance equipment. Work to be done at Whippany, N. J.

$1,060,591—**NTW Missile Engineering Inc.**, Los Angeles, for rocket motor cases.

ARMY

$5,455,000—**Continental Consolidated Corp.**, Jacksonville, Fla., for construction of launch complex 36-B for NASA's *Centaur* space vehicle at Cape Canaveral.

$4,454,576—**Paul Hardemann Co. and Morrison Knudsen, Inc.**, Los Angeles, for utilities development at NASA's Merritt Island, Fla., facilities.

$2,800,000—**Sverdrup & Parcel and Associates, Inc.**, St. Louis, for design of *Saturn V* test complex at the Mississippi Test Facility, Gainsville, Miss.

$2,000,000—**Minnesota Mining and Manufacturing Co.**, Los Angeles, for electronic equipment.

$1,059,350—**Thiokol Chemical Corp.**, Bristol, Pa., for rocket motors and igniters.

$99,000—**Allis-Chalmers Defense Products Div.**, Milwaukee, for designing, engineering and building for experimental military use three models of electric lift trucks.

NAVY

$69,565,907—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for continued research and development on the *Polaris* missile system.

$9,000,000—**Maxson Electronics Corp.**, Old Forge, Pa., for production of *Bullpup* air-to-surface missiles.

$1,372,439—**Cameron Iron Works, Inc.**, Houston, for production of guided missile boosters.

$1,288,000—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for *Polaris* test vehicles.

INDUSTRY

$1,200,000—**Avco Corp.'s Lycoming Div.**, Stratford, Conn., from **Aerojet-General Corp.**, for production of an undisclosed number of titanium second-stage rocket motor chambers for the advanced *Minuteman* missile.

Marquardt Corp., Van Nuys, Calif., from **Hughes Aircraft Co.**, for initiation of development of a reaction control rocket system for *Syncom II* (undisclosed amount).

Elgin National Watch Co., Elgin, Ill., from **North American Aviation's Space and Information Systems Div.**, for design, development and fabrication of the central timing equipment for the *Apollo* spacecraft (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and materials for erecting a blast slab, access roads, area enclosure fence and supporting facilities, all in West Area, Langley Research Center, Langley Station, Hampton, Va. In accordance with NASA Specification L-3062 and drawings listed therein—1 lot. IFB L-3062. Bid opening 3-22-62.

U. S. Army Chemical Procurement District,
New York
346 Broadway
New York 13, N. Y.

Rocket packing assembly, CMLC, Drawing No. D90-6-62, revision dated 9-7-62. Drawings, specs and standards listed on CMLC Data List DL90-6-62, and engineering modifications on page 14 of schedule. Included shall be standard rolls of steel strapping sufficient to allow 82 linear feet of strapping for each assembly—7603 each. IFB 63-122. Bid opening 3-25-63. A partial quantity of 7602 each has been set aside for concerns in labor surplus areas.

National Aeronautics and Space Administration
Procurement Office
Marshall Space Flight Center
Huntsville, Ala.

Investigation and analysis of the influence of perturbing forces on tracking of orbital vehicles. Inquiries regarding this requirement must reference TP 3-81101. Job—RFQ-TP-81101. RFQ due date 3-21-63.

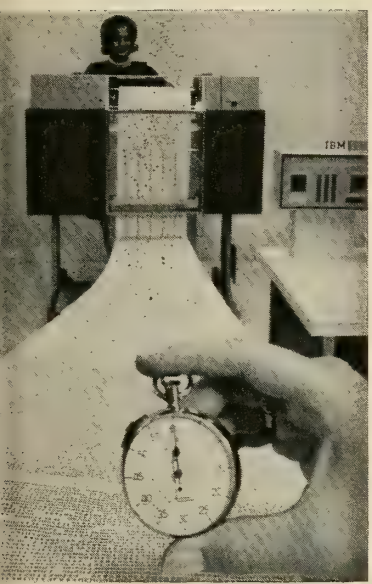
National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

NASA is soliciting a proposal for three trailers, van semi, two-wheel highway type, approximately 35 ft. long, 8 ft. wide, fully enclosed type body, 20 in. lightweight steel wheels, 900x20 tires (10 ply), standard axle 20.000 lb. capacity, brakes power, air type, heavy duty springs, upper frame, full length, no drop floor, 1⅛ in. tongue and grove, oak treated wood with wood preservative. Must sustain 13,750 lbs. fork lift—3 each. RFP CC-152-3. RFP due date 3-22-63. Contact Mr. D. S. Phelps, Tel. 305-783-7893.

products and processes

New Product of the Week:

High-Speed Printing Computer



A computer featuring a printer with nearly twice the speed of present IBM models has been developed by International Business Machines Corp.

The IBM 1460 data-processing system's faster internal processing and printing speeds offer two major advantages: the 1401 users who require increased processing capabilities now have a logical advance to a larger computer because programming systems—sets of instructions that tell the computer what to do—produced by IBM for the 1401 can be run on the 1460; and, when used as auxiliary equipment for IBM 7000 series computers, the 1460 will accelerate processing operations in many industries requiring faster printed and magnetic tape output.

The unit's printer can print both letters and numbers at speeds of 1100 lines per minute, and its memory cycle is six millionths of a second. This is almost twice as fast as the memory cycle for the 1401.

Circle No. 225 on Subscriber Service Card

I-F Amplifier

One of a series of intermediate-frequency amplifiers with center frequencies from 30 to 160 mc, Model IF-301 with a center frequency of 100 mc, is available from Loral Electronics Corp. Fully transistorized with 2N1195 types, it meets military specification MIL-E-5400. The bandwidth at 3db is 20 cycles. Input impedance is 50 ohms, while the output impedance at i-f and video frequencies are 50 ohms and 91 ohms, respectively. Voltage gain is 66db. The noise figure is 7 db. The unit features both gain control and AGC.

Circle No. 226 on Subscriber Service Card

Liquid Helium Dewar

A stainless steel liquid-helium dewar has been developed by Sulfrian Cryogenics, Inc. for experimental research in associative memory circuits. The dewar, when filled with liquid helium, maintains cryogenic temperatures in the vicinity of −452°F (4.252°K). The memory circuit is immersed in the liquid helium, the dewar is vacuum sealed and pressure is reduced until the ultra-low temperatures are achieved. Circuit wires are introduced into the dewar through a vacuum-jacketed inlet tube and connected to external computing equipment operating at conventional temperatures.

Circle No. 227 on Subscriber Service Card

Cryogenic Supply Trailer

An over-the-road trailer designed for distribution of cryogenic liquids or gas has been developed by the Cosmodyne Corp. Model WA-4 has a capacity of 600 gal. with 10% vapor space. Tank pressure is 250 psig and is built in accordance with the ASME Unfired Pressure Vessel Code. The unit permits rapid transfer of cryogenic liquids from one site to another, and it eliminates the need of special concrete pads and foundations which are required for immobile installations. This trailer can be used as a medium-capacity liquid distribution container, or as a gas source for plants and laboratories.

Circle No. 228 on Subscriber Service Card

Waveguide Isolators

E&M Laboratories has available a complete line of WR229 and WR75 waveguide isolators. Broadband units (such as the Model CS110LI, which covers the full 3.3 to 4.9 range of the WR220 waveguide, and the Model M110LI, which covers the full 10.0 to 15.0 gc range of the WR75 waveguide) provide 25 db minimum isolation, 1.0 db maximum insertion loss, and 1.15 maximum VSWR. Various narrow-bandwidth units are specified to meet many system requirements as to size, bandwidth and specifications.

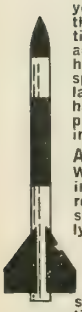
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AERODYNAMICIST
Will determine aerodynamic loading and performance of multi-stage rockets in the velocity range from static to hypersonic; establish analytical techniques; recommend model design and tests; supervise tests and be responsible for analysis of test results from models to full-scale flights. BS or MS in aeronautical engineering. Los Angeles area.

FIELD RESEARCH ENGINEER
Field Research Engineer to work with Engineering Field Director on research study of effects of ambient conditions and local tropical terrain on radio propagation. Involves design and scheduling of experiments; collection, correlation, and analysis of experimental results as well as prediction of performance in other locales. Includes supervision of technicians and local labor. Salary plus liberal bonus and living expenses. BS in EE with experiernce in communications or field testing. Location in Southeast Asia.

TEST ENGINEER
Will plan and design test programs for rocket propulsion systems; prepare schedules and coordinate program to meet schedules; analyze test results and prepare test reports; plan and coordinate environmental test program. BS or MS in ME or physics.

ROCKET TEST SUPERVISOR
Will coordinate work of instrumentation staff with other segments in test area and throughout ARC. Responsibilities include design, selection, modification and operation of instrument components and instrumentation systems used in static testing of propulsion units. Will also plan, organize and direct activities of instrumentation technicians in calibration of equipment and carrying out of tests. BS or MS in EE or physics and experience, preferably in rocket instrumentation field.

OTHER POSITIONS
. . . are available to a Sr. Controls Engineer, Reliability Assurance Supervisor, Electrical Test Engineer, Electronic Systems Engineer.

Send resume to: Dept. 217
Director, Professional Personnel

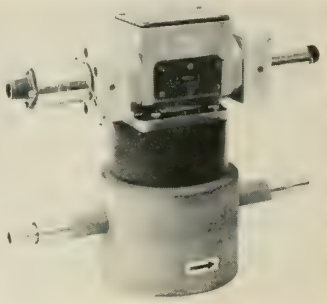
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Cryogenic Valve

A vacuum-jacketed cryogenic ball valve for handling high-pressure liquid hydrogen and helium is available from Flodyne Controls, Inc.

The valve is designed for applications requiring control of extremely low temperature liquids at high pressures.



Major features are low-torque (¼-turn), tight-sealing capability, high-speed actuation, and low heat leak. Sizes range from ¼ in. to 10 in., and pressure ranges available are 150 psi to 6,000 psi.

Circle No. 230 on Subscriber Service Card

Digital Voltmeter

Significant design advancements are incorporated into Model DVM-2 Digital Voltmeter, developed by Industrial Instruments. Read-out is furnished by premium long-life, wide angle nixie tubes. Automatic range and polarity selection is provided. It covers d-c voltage from ±0.001 to 999.9 in ranges of 0.000 to 9.999/99.99/999.9. Accuracy is ±0.01% of full scale plus one digit.

Circle No. 231 on Subscriber Service Card

Gas Flow Calibrator

An automatic gas-flow calibrator, which may be used to calibrate flow rate instruments with capacities between 25 and 24,000 cu. cm. per min. and to measure very low flow rates of inert gases, has been developed by Brooks Instrument Co., Inc.

The Porter Automatic Flow Rate Calibrator is a precision gas collecting and measuring instrument with an accuracy of 0.2% of indicated volume. A major feature of the calibrator is its patented floating piston, which uses a "unique and virtually frictionless" mercury O-Ring seal that assures positive sealing of the piston as it is forced to rise in its precision-bore glass tube by the volume collected below it.

Developed primarily for the calibration of low flow rate instruments, the unit is also used in other applications that require the precise volumetric measurement of very low gas flows.

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For JPL's new Space Flight Operation Facility. At least 4 years experience in design and operation of Data Processing & Communications Systems.

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Circle No. 11 on Subscriber Service Card

Mass Flowmeter

Technology Inc. has developed a compact device for measuring the mass flow of gases on a linear basis, thus combining the function of several laboratory instruments into a portable, hand-sized unit particularly suitable for airborne and remote installations.

Model MFM-150-1 may be used to measure the flow of any gas of known composition in the range of 0 to 150 standard liters per minute or 0 to 0.4 lbs./min. It is adaptable to any environment and compatible with telemetry systems or other recording devices.

Overall reading accuracy is ±5% of full scale in the gas flow temperature range of 60° to 100°F and can be improved still further if conditions permit calibrating the mass flowmeter for a narrower temperature range. Linearity will fall within ±3% of the best straight line.

Circle No. 233 on Subscriber Service Card

Sideband Filter

A single-sideband filter for attenuation less than 15 db has been developed by ESC Electronics. It has a carrier frequency range from 16 kc through 56 kc, nominal impedance of 600 ohms, and pass band insertion loss less than 3 db.

For communications applications, the filter has the following pass-band specifications: greater than 1.2 db between ±.75 kc and 3 kc; greater than 2.5 db between +0.5 kc and +3.25 kc; and greater than 4 db between +0.3 kc and +3.5 kc. Stop band specifications are: less than 60 db at −2 kc and below; less than 65 db at −0.5 kc; less than 35 db at −0.25 kc; less than 25 db at 4 kc, and less than 50 db at 4.25 kc and above.

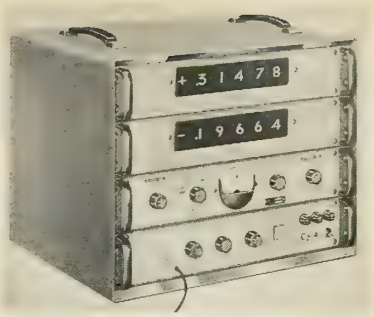
Circle No. 234 on Subscriber Service Card

Ratio Bridge

A self-nulling, complex ratio bridge which displays both in-phase and quadrature ratios on a five-place nixie readout is available from Gertsch Products, Inc. The unit automatically provides precision voltage and phase comparisons.

The Model CRB-3 features an in-phase ratio accuracy better than 0.005% of range, and quadrature accuracy better than 0.05% of range, plus calibration. Average nulling time is less than 10 sec.

Instrument measures step-up ratios as high as 1:6 to 3-, 4-, or 5-place resolution. Quadrant selection and indication are automatic. The unit is ideal for production testing of transformers, tachometers, rate gyros, transducers and AC amplifiers.



Circle No. 235 on Subscriber Service Card

Zero-Entry Connector

An all-purpose zero-entry connector for general umbilical and interstage applications in missiles is available from Wiggins Connectors.

Because of the zero-entry connection principle, such problems as contamination of sockets, mismatch, and bent or splayed pins are eliminated, Wiggins says. The plug half of the connector has 20 flex-leaf contacts that mate with 20 flush contacts in the receptacle half.

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soviet affairs

By Dr. Albert Parry

Laser light beam, ball lightning, and plasma weapons . . .

are discussed in the article "Lightnings in Orbit" in *Krasnaya Zvezda*, the armed forces daily, for January 19. The authors—Colonel V. Glazov and Engineer-Colonel V. Vaneyev—give credit for some of these experiments and discoveries not only to "the scientists of the U.S.A. and other countries," but also to Soviet radiophysicists, particularly to Nicholas G. Basov and Alexander M. Prokhorov. The authors point out that in future wars the laser light beam as well as ball lightning and plasma weapons may be used to locate and destroy enemy rockets and orbiting spaceships. They are careful to refer to American research in this direction, but are silent on whatever similar experimentation may now be going on in the Soviet Union.

More cooperation of rocket schools and troops . . .

is urged by Sergei S. Varentsov, chief marshal of the Soviet artillery forces, in a recent issue of the Moscow *Kommunist Vooruzhennykh Sil* (Communist of the Armed Forces), the semimonthly magazine of the Main Political Office of the Soviet Army and Navy. He suggests that instructors and professors of higher academies and middle and lower schools specializing in missilery should make frequent visits to rocket troops, both to help the troops "in a first-rate organization of battle readiness" and to learn from them whatever new methods may be developing in the rocket barracks through the officers' and soldiers' ingenuity. Such new methods then should be conveyed to the rocket academies and schools, "to be fruitfully and periodically discussed" at faculty meetings. Marshal Varentsov's appeal could indicate an unhealthy isolation now existing between the U.S.S.R.'s rocket schools and rocket troops.

Interchangeability of rocket specialities . . .

as the goal of rocket troops also is emphasized by Marshal Varentsov. He writes: "Each rocketman should master an adjacent specialty, so as to be ready to take over for a fellow soldier in battle." He cites the experience of Soviet artillery troops as a model. In Russian artillery, he says, there is even a special command during training exercises: "Change around!" At this command, all the gunners play a game of musical chairs, taking each other's places and different tasks. So it should be in rocketry, too, Varentsov declares. Learning an adjacent skill is a "must" for every officer and sergeant, and for every private beginning his second year of service. Other constant improvement of the rocketmen's knowledge is recommended and fostered. In *Krasnaya Zvezda* for January 25, Major M. Makarov writes that in certain rocket units on the soldiers' own initiative, groups for spare-time study of mathematics and nuclear physics have been formed.

Organization of Soviet rocket troops . . .

since the changes of three years ago has been misunderstood frequently in the West. In his already quoted article, Marshal Varentsov explains that the separate branch into which the military rocketry was elevated in 1959-60 embraces only strategic missiles. But other, tactical missiles have been furnished to the Soviet army, navy, air force, and antiaircraft troops. According to Varentsov, such non-strategic rocket units "are now the principal strength of the land forces." In a recent *Izvestia* article, Chief Aviation Marshal Constantin Vershinin remarks that "guns and machineguns have given place to rocket arms" in the Soviet air force. On the supersonic rocket-bearing planes, as well as on fighters and fighter-bombers, "air force air-to-land and air-to-air rockets have become the basic kind of weapons." In recent times, "the rocket-bearing plane has come to replace the bomber," Vershinin says.

HERE IS A PARTIAL LISTING OF CONTENTS

UNITED STATES GOVERNMENT:
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

INDUSTRIAL SECTION:
Detailed listings of major missiles/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

COMPANY REPRESENTATIVES SECTION:
Listing company representatives stationed in Washington and in most strategic missile/space areas.

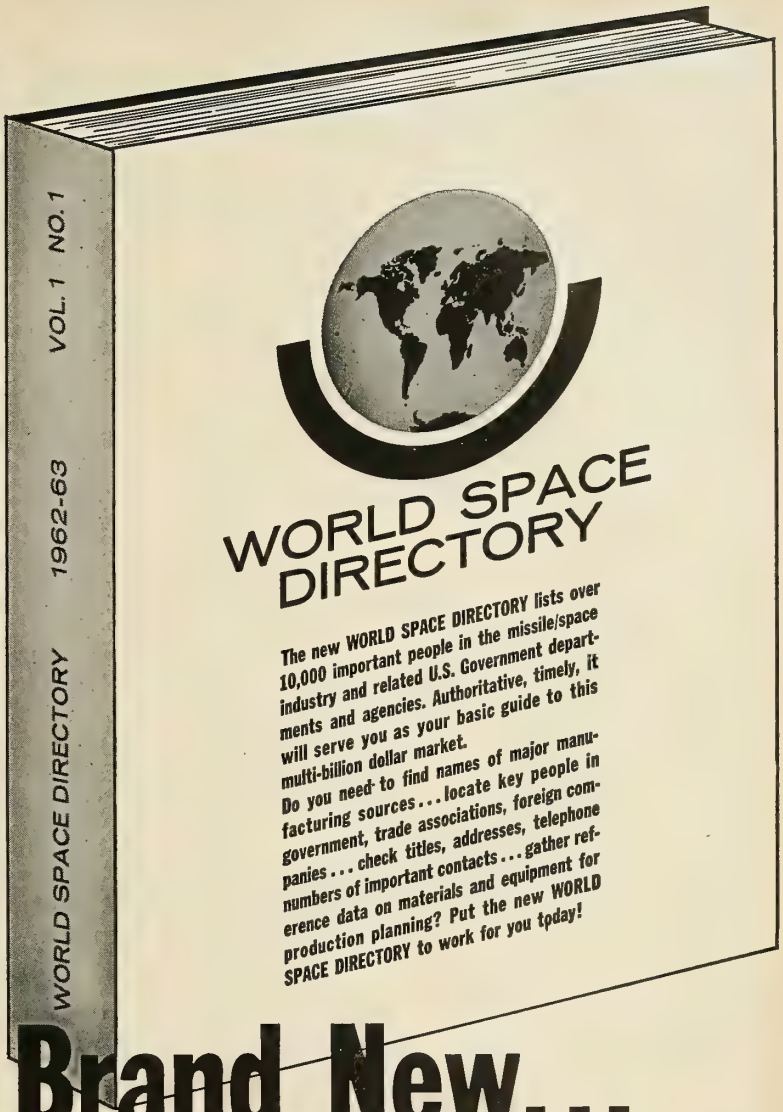
INTERNATIONAL SECTION:
Covers all countries with missile/space activities, plus all NATO member nations.

PERSONNEL INDEX:
A cross-referenced index of over 10,000 key personnel in industry and government.

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names in the news

Frank B. Carder: Appointed assistant group executive for marketing for American Machine and Foundry Co.'s Government Products Group, Greenwich, Conn.

Charles E. Johnson: Named a projects director to the technical staff of Computer Dynamics Corp., Silver Spring, Md.

H. Russell Brownell: Appointed chief engineer, electrical measurements, of the Singer Metrics Div., Singer Manufacturing Co., Bridgeport, Conn.

G. R. Makepeace: Elected vice president and director of Lockheed Propulsion Co., Redlands, Calif.

William A. Swanton: Appointed manager, fluid coupling sales, of the Power Equipment Div. of Lear Siegler, Inc., Cleveland, Ohio.

Col. Edward A. Friedlander (USAF Ret.): Named consultant, defense evaluation and consultation, Air Force, for General Electric Co.'s Defense Programs Operation, Washington, D. C.

Dr. Frederick E. Fuller: Appointed staff physicist in charge of solar power conversion programs at the Industrial Products Div. of International Telephone and Telegraph Corp., San Fernando, Calif.

Edward F. Nauman: General manager of Thiokol Chemical Corp.'s Wasatch Div., Brigham City, Utah, and **Joseph W. Wiggins,** general manager of the Alpha Div., Huntsville, Ala., named vice presidents.

Jack S. Chasteen: Appointed director of production for domestic operations for Dorr-Oliver, Inc., Stamford, Conn.

William J. Zallack: Promoted to senior methods planner of the Manufacturing Engineering Group of American Electronics, Inc., Fullerton, Calif.

John L. DiFulvio: Appointed sales manager of the Elgiloy and Precision Parts Dept. of the Elgin National Watch Co., Elgin, Ill.

Maurice W. Horrell: Named vice president-engineering and manufacturing for the UNIVAC Div. of Sperry Rand Corp., New York, N. Y.

Guy C. Throner: Named executive assistant to the manager of the Downey, Calif., plant of Aerojet-General Corp.

John A. Harper: Appointed regional director of defense systems operation for Lear Siegler, Inc., Houston.

Raymond J. Gambon: Promoted to assistant sales manager for the Garrett Corp.'s AiResearch Manufacturing Div., Los Angeles.

Norman J. Regnier: Named marketing manager of RS Electronics Corp., Sunnyvale, Calif.

Arthur R. J. Johnson: Named manager of eastern operations for the Systems Div. of Beckman Instruments, Inc., Fullerton, Calif.

Dwight Bennett: Appointed vice president and assistant to the general manager of Aero Commander, Inc., Bethany, Okla.

Addison E. Wiles: Appointed vice president-manufacturing services for the Remington Rand Div. of Sperry Rand Corp., New York, N. Y.

Edward Reynolds, Jr.: Elected vice president and treasurer of the Mitre Corp., Bedford, Mass.

Jorgen H. Bistrup: Appointed assistant director-telecommunications directorate at Page Communications Engineers, Inc., Washington, D. C.

L. L. Farnham and Charles Collis: Corporate director of advanced engineering and general manager of the Stratos Div., appointed vice presidents of Fairchild Stratos Corp., Hagerstown, Md.

Charles F. Manning: Named director of the Martin Co.'s Denver Div. Finance Dept.

Dr. Howard Reiss: Director of North American Aviation, Inc.'s Science Center, Canoga Park, Calif., elected a vice president of the company.

Irvin S. Noland: Appointed manager of the Power Equipment Div.'s central district sales, Lear Siegler, Inc., Dayton, Ohio.

Norman L. Benjamin: Appointed industrial relations director of Lockheed Aircraft Service Co., Ontario, Calif.

William B. Lynch: Elected president of Airaterra, Glendale, Calif.

Jared J. Davis: Appointed vice president of Hazleton-Nuclear Science Corp.'s Biological Sciences Div., Palo Alto, Calif.

William P. Peyser: Appointed general manager for Sanders Associates, Inc.'s Microwave Div., Nashua, N. H.

Carl Herman: Appointed materiel manager at Microwave Development Laboratories, Inc., Natick, Mass.

Lawrence T. Sullivan: Named administrator, advance planning-defense markets for the Industrial Tube Products Dept. of Radio Corp. of America's Electron Tube Div., Lancaster, Pa.

Douglas H. Blair: Named sales manager of the Precision Products Div. of Northwest Industries, Inc., Albany, Ore.

William H. Osterland: Appointed director of traffic for American Steel Foundries, Inc., Chicago.

Howard McCann: Appointed government liaison engineer for the Hicksville, N. Y., plant of Fairchild Controls Div. of Fairchild Camera & Instrument Corp.

Clayton Taylor: Named manager of Dbm Research Corp.'s Huntsville, Ala., office.

Robert S. Stewart: Named engineering manager of Ling-Temco-Vought's new LTV Michigan div., Warren, Mich. **J. W. Owens** appointed division controller. **Charles L. Brunow** appointed program manager for the *Lance* missile system and **C. B. Franklin** appointed program manager for the XM561 vehicle.

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Institute of Electronic and Electrical Engineers, Pacific Computer Conference, California Institute of Technology, Pasadena, Mar. 15-16.

Combined Meeting of American Society of Photogrammetry and the American Congress on Surveying and Mapping, Shoreham Hotel, Washington, D. C., Mar. 17-23.

American Rocket Society and Institute of the Aerospace Sciences, Space Flight Testing Conference, Cocoa Beach, Fla., Mar. 18-20.

American Society for Metals, Western Metal Exposition and Congress, Pan Pacific Auditorium, Los Angeles, Mar. 18-22.

Society for Nondestructive Testing, Spring National Convention, Ambassador Hotel, Los Angeles, Mar. 18-22.

Second Air Force Symposium on Bionics, Biltmore Hotel, Dayton, Ohio, Mar. 19-21.

Optical Society of America, Spring Meeting, Robert Meyer Hotel, Jacksonville, Fla., Mar. 25-27.

American Physical Society Meeting, St. Louis, Mar. 25-28.

Institute of Electrical and Electronics Engineers, International Convention, Waldorf Astoria Hotel and New York Coliseum, New York City, Mar. 25-28.

Fifth International Symposium on Electron Beam Technology, sponsored by Alloyd Electronics Corp., Sheraton Plaza Hotel, Cambridge, Mass., Mar. 28-29.

APRIL

American Society for Quality Control, Quality Control Conference, University Center, Western Michigan University, Kalamazoo, Mar. 30.

American Chemical Society Spring Meeting, Los Angeles, Mar. 31-Apr. 5.

American Rocket Society and Institute of the Aerospace Sciences, Launch and Space Vehicle Shell Structures Conference, El Mirador Hotel, Palm Springs, Calif., Apr. 1-3.

Eighth Midwestern Mechanics Conference, Case Institute of Technology, Cleveland, Ohio, Apr. 1-3.

American Society for Quality Control, Annual Quality Control Conference, Sheraton Hotel, Akron, Ohio, Apr. 6.

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Eulogy to a Dyna-Soar

TO ALL INTENTS and purposes, the *Dyna-Soar (X-20)* program is dead. There will now be a polite family discussion on the best way to bury the body but there is little question that the patient has passed away.

Cause of death: shortsightedness.

What could have been an active, healthy program to give this nation a growing military space capability has withered and died from the same disease that blighted the B-70 program.

Vacillation and indecision on the Dept. of Defense level have delayed *X-20* first flight dates to the point where the delay itself can be used as an argument against the program.

The death knell was sounded by the embalmers of Defense Research and Engineering who solemnly intoned: "There is no role for military man in space."

At the very best, *Dyna-Soar* will be a walking corpse dressed in the same deceptive research shroud which hides the B-70 skeleton.

There is, indeed, a possibility that the same disease will hit other Air Force manned space programs.

Under discussion as we go to press is the possibility *Dyna-Soar* will be buried in the NASA-Dept. of Defense agreement which marked the death of Air Force hopes for a separate *Blue Gemini* program.

On Jan. 28, after announcement of the *Gemini* agreement, we warned editorially: *"Dyna-Soar (X-20),* the Air Force's own military space program, is seriously threatened by the NASA-DOD agreement."

It is all too apparent that our gloomy observation was right. A prominent item on last week's agenda of the NASA-DOD *Gemini* Program Planning Board was: *X-20.*

But the widely-overlooked last paragraph of the *Gemini* agreement contains even more ominous possibilities. It reads:

"It is further agreed that the DOD and the NASA will initiate major new programs or projects in the field of manned space flight aimed chiefly at the attainment of experimental or other capabilities in near-Earth orbit only by mutual agreement."

This means that further development of such projects as manned orbital development stations also can be expected to fall under the purview of this or a similar board. Plans already are in the discussion stage.

Any hope of an effective manned military space program thus fades into the dismal prospect of a NASA-DOD board or series of boards monitoring all Air Force-proposed programs as joint projects.

This is not the way to build a military capability. It may extend military knowledge, it may develop some fall-out military technology, but it will not give this country the active military space program it needs.

NASA should be expected to assist the military space program in whatever way it can. The space agency, fully aware of its responsibility, is most willing to do this. But to suggest that NASA is a partner in the military role is to dilute and weaken the military establishment. The space agency should be responsive to military needs—not in a position to dictate those needs, through control of funding or in any other way.

Secretary of Air Force Eugene Zuckert, in a speech at Cape Canaveral on March 2, spelled out the reason very well. He noted that despite all the hullabaloo about peaceful space objectives, there is no such thing as peaceful space or military space. There is just space.

It is a place, not a program.

As the AF Secretary pointed out, the military services will have to do the same thing in space that they have always done on land, on the high seas and in the air.

President Kennedy himself has referred to space as the new ocean. Who does he expect to defend our exploration and commerce in this new ocean? NASA? The feeling seems to be that if a pirate fleet shows up, we will start building warships.

Mr. Zuckert notes the two general objectives of the Air Force forward space program:

- To acquire the capability to utilize space in support of military forces operating in the more familiar environments of land, sea and air. Such support would take the form of reconnaissance, warning, communication, meteorology and other programs.
- To acquire the necessary defense capability for the space regions themselves.

The Administration has failed sadly in making provision for the second of these two objectives, one for which *X-20* should be playing a major development role.

"We must be able to protect the peaceful activities in space of the nations of the free world," the Air Force Secretary declared. "We believe that space can be free to all for peaceful activity only if somebody keeps it free. We are that somebody."

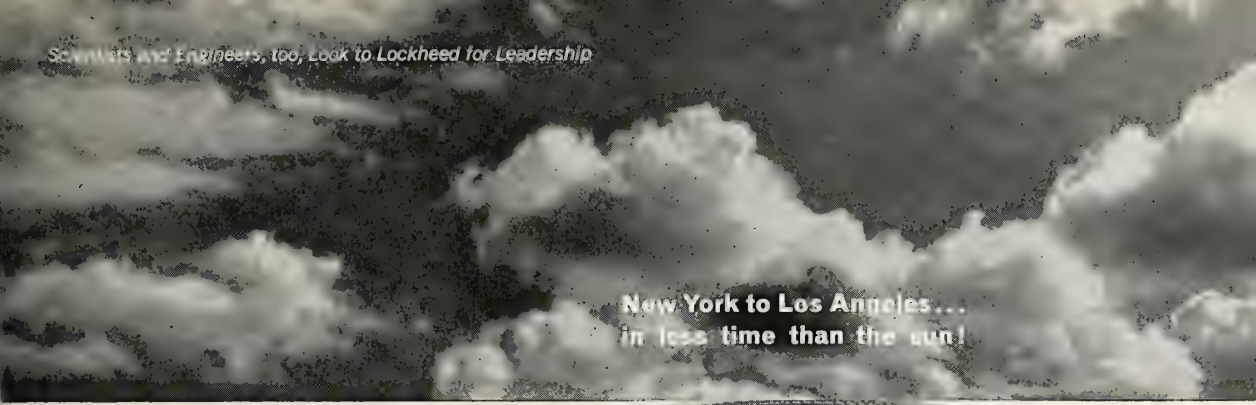
WE ARE A SOMEBODY with our hands tied behind our backs at this point. Mr. Zuckert makes it clear that he must be painfully aware of this, for he continues: "The job involves mastering the space environment in order to deny to a hostile power the uninhibited military exploitation of space. We can only do this if we have the ability to detect and counter any military threat. We believe that both manned and unmanned systems will be required, but we cannot say now in what relative investment."

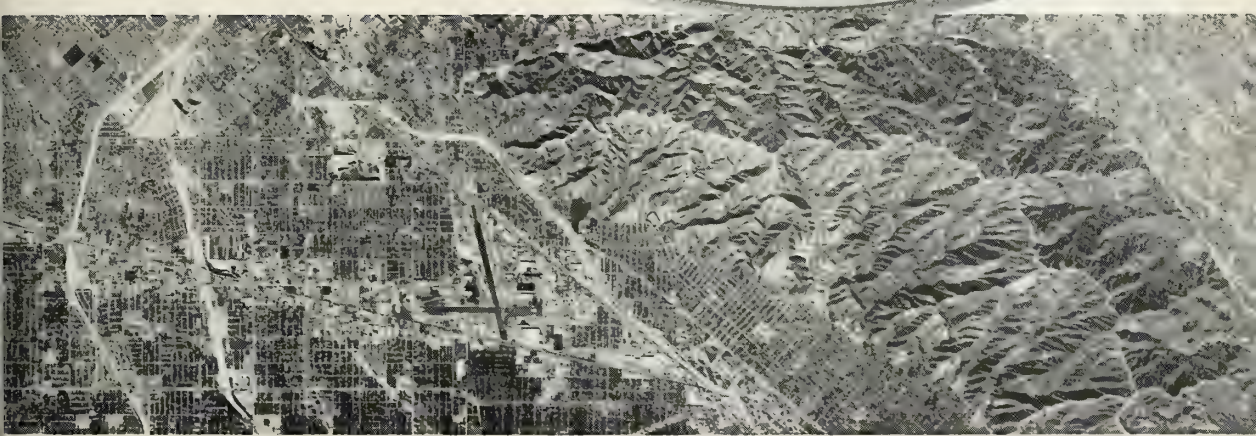
Our present and near-future capability of countering any military space threat is nil. Yet Soviet Marshal Biryuzov, commander of strategic rocket forces, declared last month that it has now become possible "to launch, at a command from Earth, rockets from a satellite, and this at any desirable time, at any point in the satellite trajectory."

We can only hope that our eulogy to the *Dyna-Soar* is not a prelude to eventual disaster for our nation. But in shrinking from the *X-20* project we are leaving the door wide open for the Soviets to precede us in development of vital technologies.

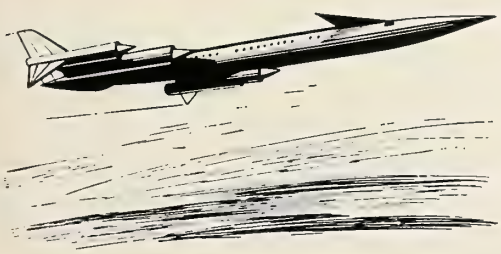
William J. Coughlin

Scientists and Engineers, too, Look to Lockheed for Leadership





TIME SQUEEZE



Time: ***NOON***

Place: ***NEW YORK INTERNATIONAL AIRPORT***

A big needle-nosed transport stands poised for take-off in the mid-day sun. Suddenly its jets roar into full-throated life. The plane arrows down the runway and into the air in a sweeping climb-out that takes it to 70,000 feet in less than 20 minutes heading westward toward the distant Pacific.

Time: ***11 AM (Same Day)***

Place: ***LOS ANGELES INTERNATIONAL AIRPORT***

Out of the eastern sky the plane descends in a long glide, its engines muted, its wings still hot from the Mach 3 speed which outpaced the sun for 2,469 miles. Result? Time is squeezed until it runs backward and the plane arrives *before* it departs—less than two hours out of New York.

FANTASTIC? Not at Lockheed California where studies involving flight characteristics and airline operation of the SST have been in process for some time. Projects like these are one reason why the Company appeals to the man who enjoys working in a creative climate that welcomes new ideas and concepts.

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This is a gyroscope with no wheels, motors, gears, bearings, gimbals, rotors, springs or bushings.

The first magnetic induction nuclear gyroscope: a laboratory model, but functional enough to prove that the principle works. Its descendants are expected to be the most precise and dependable navigation instruments ever devised.

It has a heart of water, contained in a small glass sphere. Electrical coils around the sphere align the water's nuclear particles like bar magnets. When the gyro's orientation is changed, these particles are disturbed. They emit a faint current, which signals the change . . . with fanatical accuracy.

Good mechanical gyros also sense, and signal, change of direction. But as time goes on even the best of them will build up excessive drift. Since there are no moving parts in the nuclear gyro, its drift rate due to friction is zero. Because of its simple construction, it should eventually be produced at far less cost than mechanical gyros. And it will never wear out.

The one above was built under Republic's independent research and development program, and tested under Bureau of Naval Weapons sponsorship.

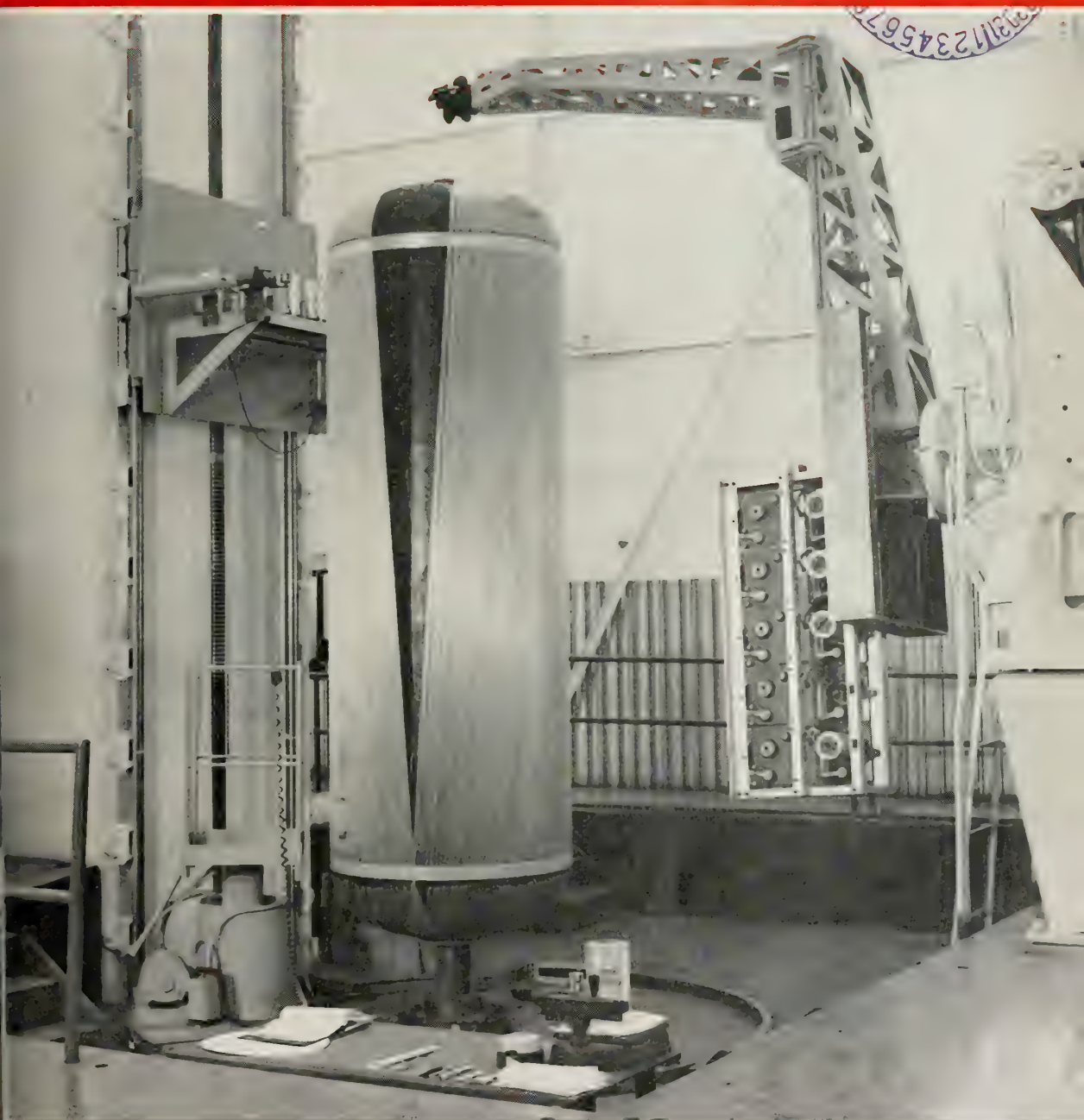
Tomorrow its descendants will guide men who travel on the sea . . . under it . . . in the earth's atmosphere . . . and beyond.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING



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Beech-built "missing link" ends make-believe training

KD2B-1, now being produced under U. S. Navy contract, is another example of Beech's systems management capability

The Beech KD2B-1—shown above—is America's first missile target system to match the performance of the fastest enemy jets. **It ends the need for target towing, faking, or simulation of any sort.** By matching actual supersonic aircraft speeds, altitudes and target characteristics, it makes possible low-cost realistic training. It can evaluate proficiency of every advanced weapons system, including radar-directed and heat-seeking missiles.

But weapons evaluation is only one of the many jobs the Beech KD2B-1 is capable of doing. It has capabilities for use as an inexpensive operational missile. Its payload capacity and low-maintenance design fit it admirably for a wide range of tactical missions.

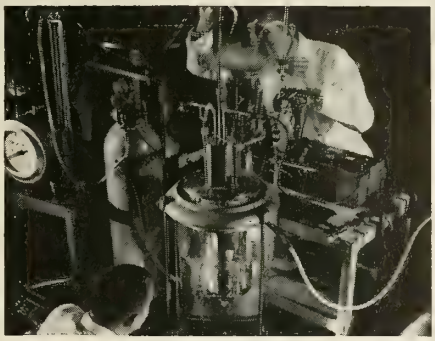
The KD2B-1 is easily adaptable to air-launching, surface-launching, or ship-launching with existing equipment. It is capable of Mach 2 speeds at 70,000 feet and Mach 3 speeds at 100,000 feet.

Designing, developing and building missile systems is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

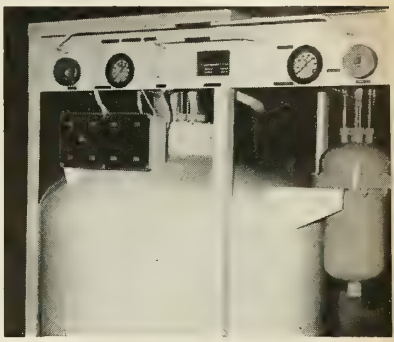
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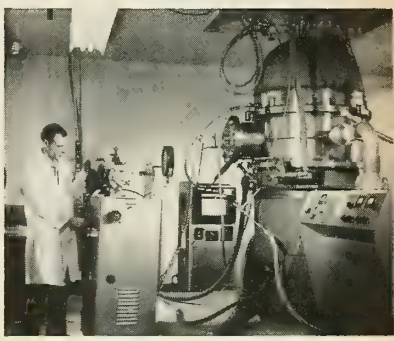
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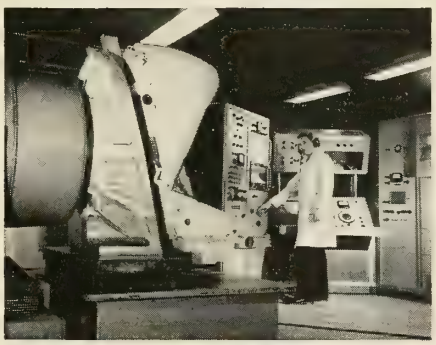
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November 21, 1918. Over the first air-to-ground radio gear, President Wilson talks to a plane circling the White House. The Bell System's new "VT-1", the world's first mass-produced vacuum tube, makes this broadcast possible.



42 years later. In a ceremony commemorating the 1918 event, an amplifier equipped with 42-year-old "VT-1's" performs perfectly as it is presented to Major General R. T. Nelson of the Signal Corps by W. H. Doherty of Western Electric.

Bell System communication component stands test of time

Military communications took a giant step forward in 1917 when Western Electric, manufacturing and supply unit of the Bell System, made the world's first mass-produced vacuum tube for the United States Army Signal Corps.

Called the "VT-1", this tube was used extensively in World War I military communications systems. It is the archetype of modern electron tube technology.

In the 1960 ceremony shown above, 42-year-old "VT-1's" matched the performance of modern tubes in reproducing voice and music!

Although the Bell System's 1948 discovery of the transistor and other developments have rendered the "VT-1" obsolete, its reliability is undiminished. As a matter of fact, it is still popular today with hobbyists and collectors who are hi-fi enthusiasts.

Reliability of this kind is built into all Bell System military communications. Bell System reliability is evidenced today, as it was in the "VT-1" back in 1917, in many military communications systems such as the DEW Line, BMEWS and others.

In the Bell System, the world's most imaginative and skilled communications specialists work ceaselessly to strengthen America's defense.

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missiles and rockets

Volume 12, Number 11 March 18, 1963

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THE COVER

Vertical winder at Aerojet-General applies longitudinal strands to first-stage Polaris A3 motor case. Winding arm at left applies hoop wrap. *See p. 34.*



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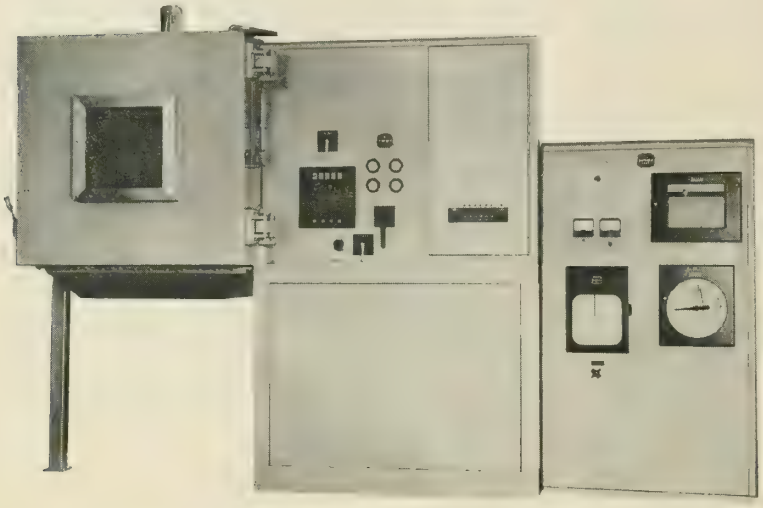
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SPACE ENVIRONMENTS WITH VERSATILITY

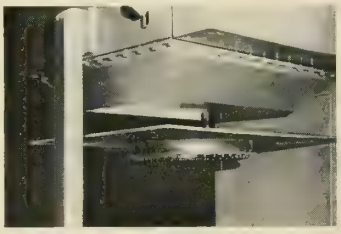
SEE US AT BOOTH 50 I.E.S. SHOW



Conrad NEW model FHV-30-5-5 Test Chamber

This new Conrad, Inc. temperature-altitude test chamber is easily adapted to standard vibration machines. During preliminary tests following installation at N.A.S.A.'s Manned Space Flight Center, Houston, the vibration machine opening was sealed off with a blank plate provided with the chamber, and altitudes exceeding 750,000 feet were obtained. This is another example of the exceptional performance and reliability that are standard in test chambers made by Conrad, Inc. Your inquiries and requests for bids on your requirements will receive our prompt attention.

WRITE FOR CATALOG



The blank off plate, shown in position, allows versatility of chamber when temperature and altitude tests only are necessary. Adapter plate for vibration unit is shown below.

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letters

Intergalactic Problems

To the Editor:

Your interview with Dr. von Karman (M/R, Feb. 25, p. 22) provided interesting insights into the scientific possibilities of space work. However, I believe the statement on an *inter*galactic probe must be a reference to *intra*galactic research.

Problems confronting a *manned* (although not so specified, presumably an ultimate goal) *inter*galactic mission are so vast that genetic aspects alone cannot properly be confronted within 50 years. A round-trip intergalactic flight would require no less than 300,000 years, and a functioning scientific community capable of self-sustenance for 3000 centuries (including propagation of succeeding generations of researchers) will be most difficult to assemble. Ramifications involving freedom of choice, particularly for succeeding generations born on the flight, must be considered. Even if relativistic effects made the journey feasible for a single generation of these intergalactic researchers, would they want to return to an Earth on which perhaps no trace of their civilization remained, or where they might feel like reincarnated Neanderthal Men in a society which had progressed for 300 millenia since their departure?

Frederick O. Kile, Jr.
Marburg/Lahn
West Germany

In the interview, Dr. von Karman made a cautious prediction that an intergalactic probe—*not a manned flight—would be made within 50 years.—Ed.*

Dielectrics Symposium

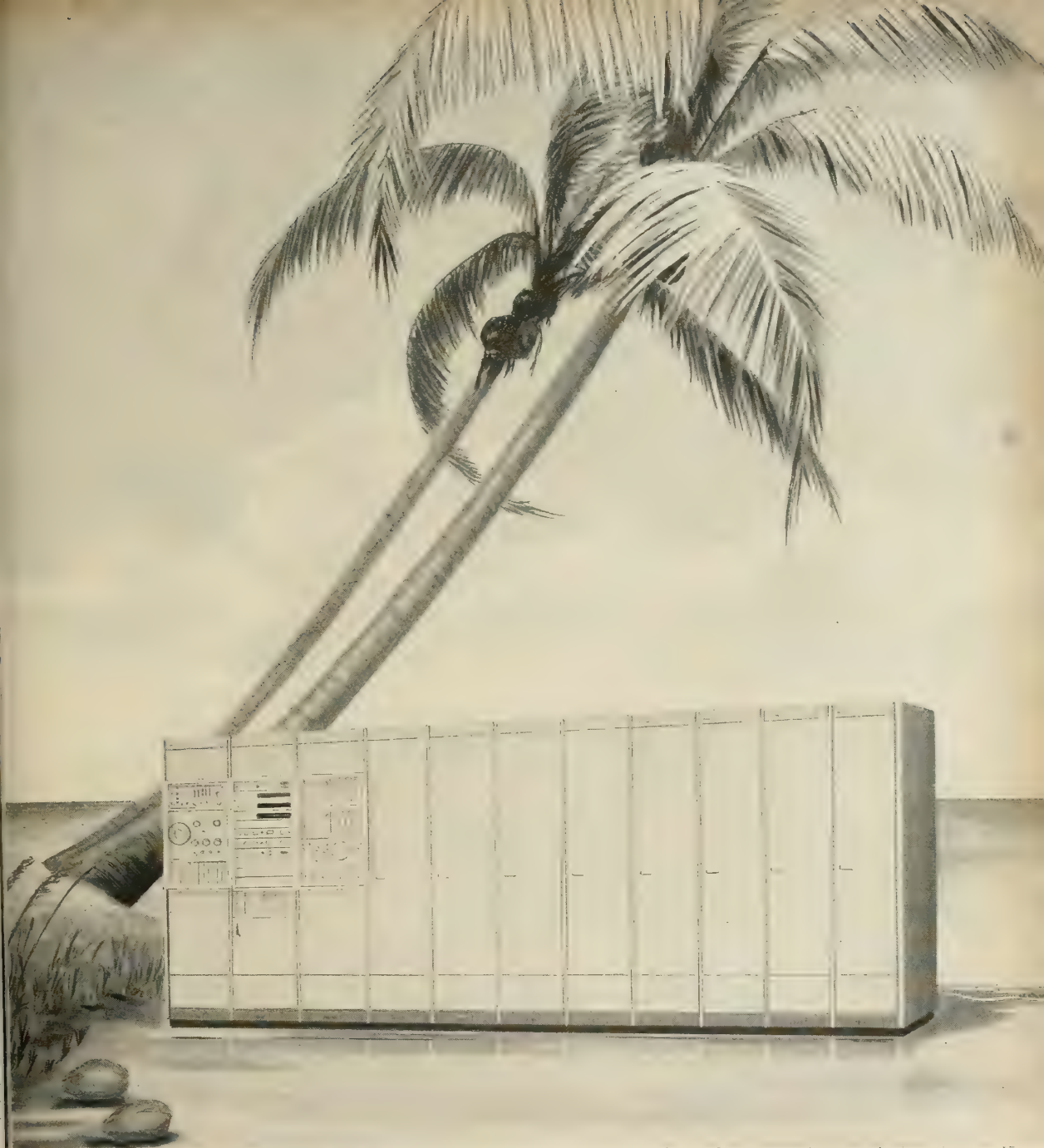
To the Editor:

A two-day symposium on the problems and application of "Dielectrics in Space" is being held at the Westinghouse Research Laboratories in Pittsburgh, Pennsylvania, on June 25 and 26. The objective of this symposium is to focus attention on the nature and solution of the dielectric problems associated particularly with space and supersonic atmospheric flight. The topics for presentation and discussion would include a variety of dielectric problems (electrical and mechanical) including: microwave properties, cryogenic properties, high-temperature properties, vacuum and radiation effects, thermal degradation, discharges, reliability, as well as components and devices which depend critically on dielectrics. Participants from universities, government, private and industrial laboratories are being invited.

A limited number of pertinent papers are being solicited to complete the program. Offers of papers or requests for information or invitation to attend the symposium should be directed to Drs. D. Berg or T. W. Dakin, Westinghouse Research Laboratories. Pittsburgh 35, Pennsylvania.

T. W. Dakin
Pittsburgh, Pa.

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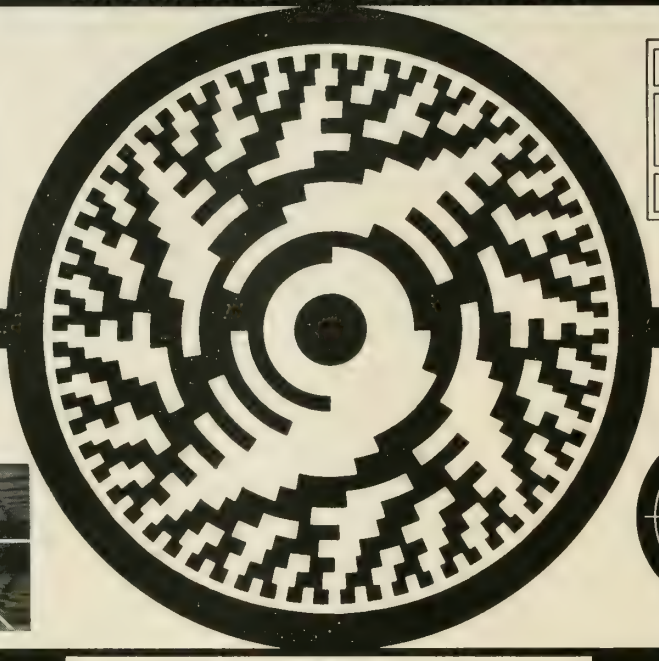
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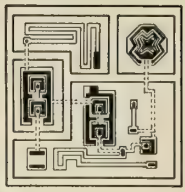
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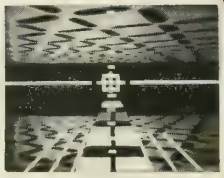
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The Countdown

WASHINGTON

Navy Seeks Second Source on Bullpup Motor

Navy is expected to award a second-source contract on the *Bullpup* missile propulsion system before the end of the month. Successful bidder probably will come on stream for Fiscal '65 procurement of the air-to-ground weapon after turning out a pre-production quantity to qualify.

SAC and the Beanstalk

Strategic Air Command is going into production with the *Beanstalk* rocket-borne emergency communications system. The system is designed to provide emergency transmission of the "go" signal to SAC forces if all other systems are wiped out. It is based on Hughes Aircraft work in Project *Tattletale*. Ling-Temco-Vought will build the missiles, which will be emplaced in hard sites.

NASA Asks Navigational Satellite Funds

NASA is requesting some $600,000 in the Fiscal '64 budget for studies of a navigational satellite system. This is double the amount provided in the FY '63 budget.

A Railroad into Space

NASA may share 50-50 the cost of funding a railroad spur onto Cape Canaveral. Estimated cost to the space agency: $2 million for the 20 miles of track, with the Florida East Coast Railroad putting up an equal amount. Traffic is expected to average 225 freight cars daily. By way of comparison, the city of Miami averages 137 cars a day. Next step: possible NASA contribution to development of the Titusville-Cocoa airport.

NASA, DOD Sign Satellite Agreement

Dept. of Defense and NASA have signed another space agreement. It establishes the working arrangements between the two agencies concerning non-military applications of the *Transit* navigation satellite system. Navy will continue to have full technical direction of the system but will provide NASA with the information necessary to develop non-military equipment compatible with *Transit*.

Large-Scale Shrike Buy Anticipated

Texas Instruments is expected to establish a high production rate on the *Shrike* Navy-sponsored anti-radiation missile, also to be procured for the Air Force. Reason: designed primarily for use by tactical aircraft, *Shrike* will be expended in fairly high numbers.

INDUSTRY

Telstar II Launch Set for May

AT&T has scheduled the launching of *Telstar II* for early May. This means NASA, to avoid a conflict of in-flight testing, will delay its second *Syncom* satellite, which could be ready next month.

NASA Signs LEM Contract with Grumman

After four months of negotiations, NASA has signed a $387.9-million cost-plus-fixed-fee contract with Grumman Aircraft for the Lunar Excursion Module of Project *Apollo*. This calls for nine ground-test models and 11 flight versions of LEM.

NASA Establishes Industry Study Team

NASA has asked a top official of Airborne Instruments Lab to head an industry committee which will make a worldwide management study of space agency operations.

INTERNATIONAL

British Set Up Unified Defense Ministry

The British government has decided to set up a unified Ministry of Defense along lines which closely resemble the reorganization of the Pentagon by Secretary of Defense McNamara. The Admiralty, War Ministry and Air Ministry will be abolished, with ministers now responsible for the three services to be downgraded and made directly subordinate to the Minister of Defense. Research and development responsibilities in relation to weapons will be immediately transferred to the new Ministry.

Radio Moscow Reports "Skybolt" Development

Radio Moscow says Russia has an airborne bombardment missile that can be launched at targets "hundreds of miles" from the bomber carrying it. Description of wings and tail assembly of the missile, carried by the long-range Tu-20 turboprop bomber, indicates it probably is not ballistic.

British Government Okays ComSat Plans

The British government has announced plans for development of its own communications satellite system. First step: a study contract. Probable booster: a three-stage vehicle based on *Blue Streak, Black Knight* and a new third stage.

French Planning Large Nuclear Missile Program

A top French general discloses that France is building more than 200 missiles capable of carrying nuclear warheads. He says the proposed NATO force, when compared to this, is "nothing more than a multilateral farce."

British Still Studying Spaceplane

Britain's Royal Aircraft Establishment still is studying plans for a two-stage system which could put a small spaceplane into Earth orbit with a recoverable booster craft. The Minister of Aviation says development of special materials needed already is under way.

Ikara Sea Trials Called Successful

First sea trials of the Australian *Ikara* antisubmarine missile ended early this month. Range of the weapon, which employs a rocket to boost a homing torpedo through the air, is said to exceed 15 miles. Trials were declared a success. U.S. Navy is interested.

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The Missile/Space Week

Apollo Slips Laid to Kennedy

D. Brainerd Holmes, director of NASA's Manned Space Flight Office, testified before a House Space Subcommittee that both *Gemini* and *Apollo* programs were delayed about five months because the Administration refused to ask for supplemental appropriations to the Fiscal Year 1963 budget last fall.

Holmes' statement was made in response to questions from Reps. Emilio Q. Daddario (D-Conn.) and James G. Fulton (R-Pa.). Neither Congressman pushed for further explanation of the slippage apparently in an attempt not to embarass the NASA official by putting him on the spot for something which was out of his control. The implication was that the refusal to seek more funds was a Kennedy decision.

ASD Reorganized

The Aeronautical Systems Div., Air Force Systems Command, has been realigned to place a number of activities into a single package for transfer to the Research and Technology Division.

Applied research, advanced technology, systems engineering, and advanced systems studies and analysis are being shifted from ASD to RTD as part of a move to make RTD responsible for all AFSC exploratory research and advanced development.

The realigned functions at ASD are being placed under a deputy commander, but no personnel or facilities will be moved to RTD (at Bolling AFB, Wash., D.C.). AF says prime reason for the shift is to strengthen its in-house capability in R&D and to provide centralized planning and direction of its programs.

Hill May Snag ComSat Corp.

Proposed incorporators of the Communications Satellite Corp. faced a stiff round of questioning from members of the Senate Commerce Committee last week.

Discussion regarding possible duplication of effort by NASA and the ComSat Corp. indicated possible further delay of Congressional confirmation for the incorporators named by the President to establish the firm.

Sen. Clinton Anderson (D-N.M.), chairman of the Space Committee, asked whether the $55 million sought by the space agency for space communications research in the coming fiscal year might not duplicate efforts in the same area by the corporation.

Sen. Mike Monroney (D-Okla.) again raised the issue of whether tax money should be spent on research that ultimately would benefit a private firm such as the ComSat Corp.

Anderson reserved the right of the Space Committee to question the incorporators at greater length later about possible overlapping of funds in communications research.

Sergeant Going to Europe

Sperry Utah Co.'s 86-mi. range *Sergeant* surface-to-surface missile will begin replacing aging *Corporal* weapons in Europe this month, according to a Defense Dept. announcement.

The *Sergeant* was first fired successfully by an Army tactical unit last October (M/R, Oct. 29, p. 16). The initial increment of weapons to go to Europe will be a battalion, with additional units to beef up the European Command over the next several months.

Space Lab Seen 2 Years Away

A four-man space laboratory could be operational in only two years, say officials of Douglas Aircraft Co.'s Missile & Space Systems Division.

An unsolicitied proposal to NASA from the firm stresses the economy possible with an off-the-shelf package using only one new structure—the command-control module.

Components would be made up of proven hardware and equipment, including a *Gemini* shuttle vehicle. Subsystems would be adapted from existing hardware.

Major laboratory and living area would be provided by an expended *Saturn I* second stage, tankage of which would be purged and refurbished by the crew after attaining a 250-mi. orbit.

Shots of the Week

The U. S. S. Thomas Jefferson nuclear submarine batted .500 in two *Polaris* firings from beneath the Atlantic near Cape Canaveral March 7.

The first launch at 12:49 p. m. failed when the Lockheed missile apparently went off course. The shot failed within seconds, it was reported, but there was no indication

as to what caused the missile to go off course.

One hour later, the sub fired a second *Polaris* on a flawless 1400-mi. flight.

- An Army Martin *Pershing* was fired successfully from a Cape Canaveral pad March 13.

The missile was a helicopter-transportable version of *Pershing*.

- An Air Force combat crew successfully launched a General Dynamics/Astronautics *Atlas* ICBM in a routine training flight from Vandenberg AFB March 12. The crew was from Warren AFB, Cheyenne, Wyo.
- A space probe using a *Blue Scout* booster combination was launched from Pt. Arguello, Calif., March 13. A brief AF announcement confirmed the shot, but gave no details.
- An *Atlas* launched March 9 from Vandenberg AFB exploded shortly after leaving the launch pad. The Air Force said cause of the explosion has not been determined.

Nimbus TV Camera Detailed

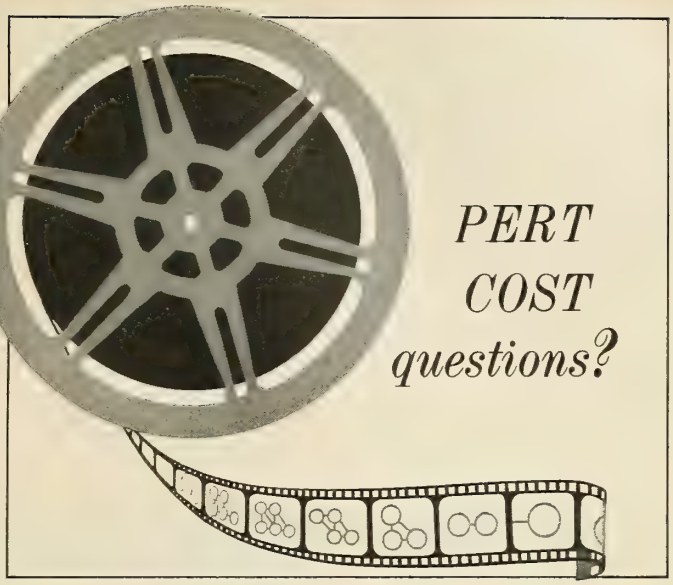
The day/night television camera for the *Nimbus* meteorological satellite will be capable of 24-hour automatic control over an illumination range of from 10^4 (sunlight) to 10^{-5} (night) foot-candles.

Now being developed by Hazeltine Corp., Little Neck, N.Y., for NASA's Goddard Space Flight Center, the fully transistorized camera (excluding the lens) will weigh less than 15 lbs.; occupy about ⅓ cu. ft.; and require only 30 watts of power.

Under a $100,000 contract announced last week, the company will build one evaluation model for delivery to NASA next November.

The TV subsystem, according to developers, will employ a miniature, fully-electrostatic image orthicon. A combination of variable neutral-density filter discs and a pulsed photocathode will provide the automatic control necessary for day/night operation. A photocell surveys the brightness of the scene to be recorded and activates a servo motor to control light filtration.

Flow of the electron image from the photocathode to a target will be controlled by pulsing the image section of the image orthicon, thus serving as a variable-speed electronic shutter. The magnesium-oxide target will be used to permit slow-scan readout (six sec.). The shutter—to be synchronized with respect to orbital speed to stop the image motion—will be designed with a shutter speed of from 50 microsec. to 50 msec.



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Big payload attractive . . .

Titan II-Centaur Hybrid Studied

Martin Marietta Corp. may get feasibility study contract; modified Surveyor Moon lander likely mission for booster

by Hal Taylor

NASA is seriously considering a *Titan II-Centaur* booster combination and is expected shortly to announce the award of a contract to the Martin Marietta Corp. to study its feasibility.

Agency officials are attracted by a reported 1000-lb. increase in payload capability compared to the current *Atlas-Centaur* launch vehicle.

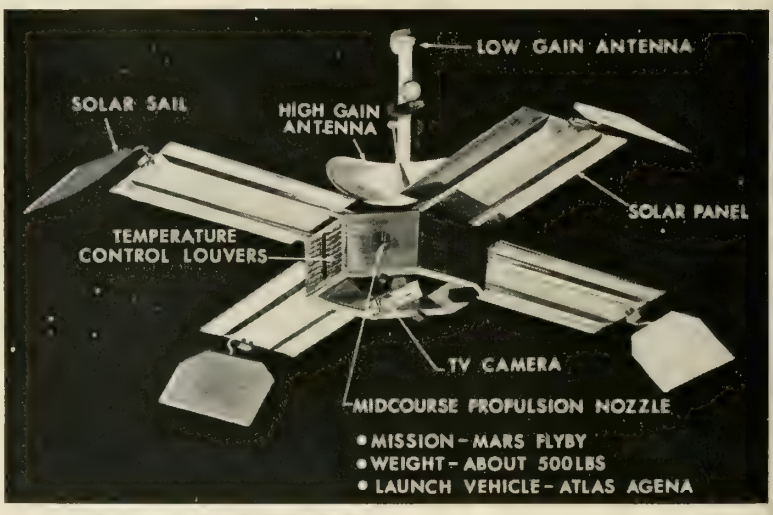
If the booster proves to be feasible in terms of cost and scheduling it could be used throughout the agency's lunar and planetary programs. One specific mission would be a modified *Surveyor*-type spacecraft—currently under study—which would land on the Moon and then move about exploring the lunar surface.

Disclosure of the impending award on *Titan II-Centaur* was only one of the major developments last week in NASA lunar and planetary programs. Among the others:

—Top officials have given the go-ahead to the *Surveyor Orbiter* program, which will have an estimated cost of $150 million. The agency's top management is now considering whether to ask industry for bids on the 1800-lb. spacecraft or simply award the contract to the Hughes Aircraft Corp., prime contractor for the *Surveyor* soft-landing vehicle.

—Northrop Corp. has been selected as the industrial support contractor for the first phase of the *Ranger* spacecraft program, covering launches through 1964. The firm is also expected to be named prime contractor for the second phase of the program, beginning with spacecraft scheduled to be launched in 1964.

—NASA has asked industry to submit bids by March 25, on two study contracts for the *Voyager* planetary spacecraft designed to land capsules on Mars and Venus after 1967. Companies are to concentrate on a spacecraft weighing 6000-7000 lbs. which would be launched by a three-stage *Saturn 1B* booster.



NASA ARTIST'S concept of Mariner spacecraft for 1964 Mars mission.

Agency officials recently told a House space subcommittee that hardware funds will have to be approved in Fiscal 1965 if the spacecraft is to meet the planned launch schedule. The contractors will also consider the possibility of increasing the weight to 60,000 lbs. for an advanced *Voyager* which would be boosted by the *Saturn V*.

• **Combination looks good**—*Titan II-Centaur* study contract would be announced in the near future.

They pointed out that they are presently satisfied with the *Atlas-Centaur* combination, but that use of the *Titan II* booster has looked promising in preliminary analysis.

They said a decision as to whether to go ahead with development of the combination will be made following completion of the study.

The study will include a complete rundown on what modifications would have to be made to both the *Titan II* and *Centaur*; estimated cost; development schedule; and how it would affect reliability in the lunar and planetary program.

Current quoted escape payload for the *Atlas-Centaur* combination is 2300 lbs. This makes it marginal for some missions, especially the *Surveyor* lander spacecraft which weighs 2100 lbs. It is also quite possible that the spacecraft weight will increase or the *Atlas-Centaur* capability will be reduced.

• **Surveyor**—Approval of the *Surveyor Orbiter* program was revealed by Homer E. Newell, director of NASA's Office of Space Sciences, at House Space Subcommittee hearings.

He said the program would cost $150 million, with six launches beginning in early 1965. By comparison, the *Surveyor Lander* project will cost $500 million, covering 17 missions with a launch rate of 5 to 7 per year.

Newell told the subcommittee NASA has decided that the *Orbiter* combined with the *Lander* "will be the most efficient" method of scientific ex-

ploration of the Moon prior to the first manned landing.

Plans call for several *Landers* to be launched before the first *Orbiter* will be ready for flight. Once both are operational, the *Orbiter* will be used to locate likely areas for the *Lander* to descend on its soft landing. Once on the surface, *Lander* will automatically proceed with experiments aimed at making the manned lunar landing as safe as possible. About a year after *Orbiter* is operational, sometime in 1967, a manned *Apollo* moon-fly-by experiment will begin. Circumlunar missions will be attempted.

Newell told the committee the *Orbiter* project was necessary despite the fact that manned missions will follow closely after it. "It is our judgment not to delay the *Orbiter* program because . . . it has been our experience that the larger projects usually always end up behind schedule as a result of complications during development, and we feel it is wise to have the *Orbiter* in operation in order to cover all our bets," he said.

Newell also said there was no duplication in the *Ranger* and *Surveyor* programs.

Ranger, with its impact landings on the Moon's surface, is expected to transmit vital, although limited, information on lunar conditions. Such information, he said, is a necessary preliminary to the *Surveyor* series.

"You can't build a sound scientific theory on a single experiment. An integrated series of experiments in combination will give us more reliable results," Newell noted. The overlapping of the relatively simple *Ranger* with the more advanced *Surveyor* will supply the answers NASA critically needs, he added. Along these lines, he said that design for landing gear of the Lunar Excursion Module will not be started until *Ranger* and *Surveyor* "tell us the type of surface on the moon."

Edgar M. Cortright, Newell's deputy, said that in addition to its decision on the *Orbiter,* NASA is giving serious thought to substituting *Surveyor* for the cancelled *Prospector* program. He said the agency has under study plans to place a lightweight, less elaborate mobile craft in a modified *Surveyor,* using a *Centaur* launch vehicle, for remotely controlled ground exploration of the Moon. If this project is feasible, he added, NASA hopes to have a *Surveyor* mobile unit in operation by 1966.

● **Ranger**—Northrop's industrial support contract will include assisting JPL in design, reviews, reliability studies, documentation, systems testing and checkout. If it is selected as the program's prime contractor, its responsibilities will include fabrication, assembly and spacecraft launch operation.

The contract will be financed out of the JPL's *Ranger* program funds. It is estimated that the cost of Phase I will be about $2 million. Total value of the contract will depend on a decision as to the scope of the work performed by Northrop if it is selected for Phase II.

Five *Rangers* have been launched to date. The first two were intended to flight-test major spacecraft systems. Both failed to achieve the planned highly eccentric Earth orbits because of launch vehicle malfunctions. The last three *Rangers* were designed to hardland instrumented capsules on the lunar surface and to take television pictures prior to impact. Two of these missed the Moon, while the third impacted on the far side of the Moon instead of the near side.

To pinpoint the source of *Ranger* spacecraft malfunctions, Dr. Newell appointed a special board of inquiry in November, 1962.

On the basis of the board's recommendation, a decision to select an industrial support contractor for the program was made.

Two of *Ranger's* most important subsystems—the attitude control and the control computer and sequencer—already are under contract to Northrop. NASA said that because of Northrop's prior work on *Ranger* subsystems, "it is in the best position to undertake the very difficult task of assuming responsibility for an important portion of a rapidly progressing program with minimum disruption and loss of time."

Current plans call for launch of the next *Ranger* spacecraft near the end of 1963.

SPO Officer Voices Confidence in Future of Titan III Program

TEXT of recent remarks by Col R. M. Herrington of the Titan III *System Program Office at a meeting of the San Francisco Chapter of the Aviation/ Space Writers Association.*

The Air Force *Titan III* Standard Space Launch well may be the single most important step we can take *today* leading to the capability to perform a military function in space *tomorrow*.

I think it is most important to set the record straight. There have been a number of press reports speculating that the Air Force *Titan III* Program will be short-lived. Some reporters have concluded this because they say *Titan III* has been justified solely as the booster for the *X-20 Dyna-Soar* and if the *Dyna-Soar* is shelved, then there is no need for the *Titan III*.

I cannot comment on the future of the *X-20*. It is not an SSD program. But I can most emphatically say that *Titan III* was *not* justified on the basis of boosting the *Dyna-Soar* or any other *single* payload. *Dyna-Soar* happens to be the only specific payload presently publicly identified with the *Titan III* system.

As far as the *Titan III* is concerned, *X-20* is just a *payload,* one payload out of a variety of military payloads the *Titan III* is capable of launching during the next decade.

The press, particularly the trade magazines and the national news publications, have also dwelled at some length on the so-called eight questions which Secretary McNamara has asked concerning the *Titan III* System. Only two days ago, an industrial intelligence organization which circulated a wire service to subscribers indicated the future of *Titan III* was in jeopardy. They quoted individuals who are supposedly extremely close to the program to the effect that DOD would elect to cancel or stretch out the *Titan III* Development Program.

I can tell you that no one is closer to the *Titan III* Program than the System Program Director—and my boss—Col. Joe Bleymaier. Col. Bleymaier does not share these opinions.

We feel that the more the Dept. of Defense scrutinizes the *Titan III* and the military requirements which gave it birth, the stronger the justification for the program becomes. I might also point out that the *Titan III* isn't just an Air Force program—it is a Dept. of Defense program, and its development on an urgent basis was recommended by the Large Launch Vehicle Planning Group—a joint DOD and NASA group convened at the direction of the Chief Executive to study and make recommendations on the requirements of our entire National Launch Vehicle Program. This group recommended the *Titan III* development to fulfill *clear-cut* military requirements just as it recommended the development of the *Saturn* family of launch vehicles by NASA to fulfill the requirements of our civilian space program.

X-20 Decision May Have Come Earlier

Rubel and Kavanau made same trip earlier; then briefed secretary, McMillan, Schriever

by Frank G. McGuire

IT APPEARS this week that the fate of the *X-20 Dyna-Soar* may have been firmly sealed before Defense Secretary McNamara's much-publicized inspection trip to *X-20* and *Gemini* installations.

MISSILES AND ROCKETS has learned that a previous, unannounced visit was paid to the same installations by Assistant Defense Secretary John H. Rubel —a long-standing opponent of military space—and Special DDR&E Assistant for Space Dr. L. L. Kavanau.

Upon returning from their trip, Rubel and Kavanau briefed McNamara, Assistant Air Force Secretary Brockway McMillan, Air Force Systems Command's Gen. Bernard A. Schriever, and other top defense officials in a March 8 secret conference at the Pentagon.

A day earlier, on March 7, the NASA/AF *Gemini* Program Board met for the second time. There was no recorded mention of bringing *X-20* under the aegis of the AF-NASA agreement (see text, M/R, Jan. 28, p. 14) which now covers *Gemini*, and no reason was given for the exclusion of this major item from the agenda. The board heard an Aerospace Corp. representative give a briefing on the *Gemini* launch vehicle (M/R, March 11, p. 14).

Both Rubel and Kavanau cancelled their scheduled participation in the trip by the McNamara group.

Testifying before the House Science and Astronautics Committee before his trip to Houston's Manned Space Flight Center and Seattle's Boeing plant, McNamara said: "I guess that we will find that *Gemini* has a greater military potential for us, even though a rather ill-defined military potential, than does *Dyna-Soar*. Moreover, it will be available much sooner than *Dyna-Soar*.

"I think the *Dyna-Soar* project can work out satisfactorily. The real question is what do we have when we finish it? It will cost to complete, in total, including funds spent to date, something on the order of $800 million to $1 billion. The question is, do we meet a rather ill-defined military requirement better by proceeding down that track, or do we meet it better by modifying *Gemini* in some joint project with NASA?"

Joining with NASA in the *Gemini* agreement, said the Defense Secretary, was an attempt to cover two bases.

"At some point, we ought to give up covering two bases and decide which one we want to cover before we have spent a total of roughly $800 million for *Dyna-Soar*—rather over $800 million for *Gemini*, and a total of $1.6 billion. I think we can cut back very substantially while better meeting both our requirements, and this is our objective."

Strongly recalling the language used in explaining why *Skybolt* was cancelled, this statement leaves little question as to the *X-20* decision.

● **Rubel comments**—In a speech delivered the same day the DOD team left to visit the *Gemini* and *X-20* facilities, Rubel stated:

"The rate at which government support of research and development has increased in recent years cannot go on forever. . . . It is obvious that a vast segment of industry does not share directly and probably shares very little even indirectly in the techniques and the approach to problems which have stemmed and are stemming from the military space programs that account for the bulk of federally supported research and development.

"It is clear, also, that these R&D expenditures often serve comparatively narrow purposes. They may be, and hopefully in all important cases they are, necessary purposes. But although necessary they may, from a national standpoint, be more costly than we have tended to realize. The purposeful broadening of the objectives that are served by federally-supported research and development activities would appear to be clearly in the national interest, and certainly in the national security interest."

● **McNamara team**—With Defense Secretary McNamara on his 30-hour visit to major facilities of both manned space flight programs were Air Force Secretary Eugene Zuckert, Director of Defense Research and Engineering Dr. Harold Brown, Assistant AF Secretary (R&D) McMillan, Gen. Schriever, and Dr. Robert C. Seamans, Jr., NASA Associate Administrator.

First stop on the trip was the Manned Space Flight Center in Houston; next was Boeing's plant in Seattle. Announced purpose of the trip was to enable a briefing by NASA, AF and Boeing on the two programs.

Asked whether the *X-20* program was really in trouble, a DOD spokesman said as late as March 12: "The Defense Department is constantly reviewing all major programs to determine their long-range value."

● **Capabilities**—Advantages in *Gemini* the AF can use include a less expensive booster, earlier availability, use of the mated *Agena's* engine, and two-man crews instead of one. Its landing "footprint" of 200 miles width by 400 miles in length gives considerable maneuverability within the atmosphere, but not as much as would *Dyna-Soar*. However, sources point out that *Dyna-Soar's* principal area of operation is space, not the atmosphere.

● **Ferguson warning**—While the Pentagon meeting was hearing Rubel's account on his trip, Lt. Gen. James Ferguson, AF Deputy Chief of Staff for Research and Development, was telling the House Committee on Science and Astronautics:

"Space is not remote. *Vostoks* have traversed the United States many times. In doing so, they passed closer to our inland cities than have any enemy craft ever before in our history, by land or sea or air. No other medium provides routes for such rapid access to every part of our country as does space. This new medium is, therefore, a potential new dimension of danger, and threat, which we cannot afford to ignore.

"It is axiomatic that we will learn the military meaning of space in one of two ways: either through exploring the military potentials of space ourselves or by observing demonstrations made by our enemies. In the latter case, it would be too late to make use of our dangerously acquired understanding.

"History records that an acceptable peace in any medium has been maintained only through the existence of ready military strength applicable to that medium. Unfortunately, it also records that every medium affording military possibilities has been used for military purposes." ■

By space agency . . .

Plan for Sharing Know-How Pressed

Lingle given management of effort to disseminate knowledge; pilot study reveals some specific applications for industry

NASA IS SWITCHING management of its industrial applications program in an effort to speed up the project designed to make space age know-how available to American industry.

The project—currently under direction of the Office of Applications—will be placed under the jurisdiction of Walter L. Lingle, Jr., Deputy Associate Administrator for Industrial Affairs.

The move is expected to be announced in the near future, informed sources report. It was portended last week, however, when NASA announced the appointment of Lingle to head its Industrial Applications Advisory committee.

Officials report that the program has been beset by patent problems and the reluctance of industry to report new technological discoveries developed under NASA contracts.

It is hoped that Lingle, who has had long experience in business, will be able to unravel the problems and get the program rolling.

● **Fruits forthcoming**—Despite the difficulties involved, officials said they will announce in the next few months some new developments which NASA feels may result in new industrial processes, techniques, devices and materials.

It is expected that standard press releases, agency technical publications, small monographs, and presentations before technical and professional associations will be used to disseminate the material.

The information will be gleaned from reports filed by NASA scientists and engineers on individual innovations which they feel have an industrial application.

The reports are screened by industrial application officers located at each NASA center. Promising innovations are sent to NASA headquarters, where a three-man screening board makes a further selection.

The reporting program was initiated in July, 1962. By December 31, over 500 reports of new developments by NASA engineers and scientists were received at NASA headquarters. Of the first 100, one official said, about 40 had good potential and five major potential for industrial application.

In its effort to get the program rolling, NASA's Office of Industrial Applications has been aided by a pilot study conducted by the Midwest Research Institute under Dr. Charles Kimball. The institute went to NASA centers to check on new discoveries and then briefed industry to see how much potential they had for industrial applications.

● **Samplings**—Breakdown of some of the Institute's findings included:

—The Marshall Space Flight Center uses a high-energy metal-forming process, called "magnetic pulse forming," by storing electrical energy equivalent to 5-10,000 ft.-lbs. in banks of electrical capacitors. By means of special switches, dumping this energy into an induction coil in less than 100-millionths of a second, an intense magnetic field is set up which forces metal to expand or contract against dies or even a mating piece. NASA's contribution to this recently developed technique is the extension of its use to very large pieces.

—In a visit to the Jet Propulsion Laboratory (JPL) the use of fluoroethylene propylene (F.E.P.) release coatings was noted. These coatings were being used to release the aluminum star-shaped insert from the sticky solid rocket propellant which was cast into the motor case.

It is known that these coatings could be used on plywood laminating presses, furniture, gluing clamps or rubber gasket molds. The advantages are that the coatings are thin, easy to cure, last a long time, and nothing appears to stick to them, not even epoxy resins or urethane foams.

—In its effort to simulate the conditions under which a space vehicle reenters the atmosphere, the Ames Research Center adapted for its use a stirred arc gas heater. This heater employs a radial magnetic field to rotate an electric arc at high velocity between two circular water-cooler electrodes. It is estimated that use of this heater to convert natural gas into acetylene may result in a considerable reduction in the cost of producing acetylene. ■

McNamara Proposes New ALBM System

A NEW air-launched ballistic missile program teamed up with a new manned bomber has been proposed by Secretary McNamara.

Emphasizing that the manned bomber, even with missiles, is not as flexible as hardened ICBM's or submarine-launched ballistic missiles, the Defense Secretary told the House Armed Services Committee that he has asked the Air Force to "consider an alternative bombing system." But he added that he did not mean gravity bombing only.

"I don't want to mislead you on this," he told the committee, "and I don't think that you yourselves fully appreciate that the term manned bomber applies to two entirely different weapon systems. One is a system that depends on the gravity bomb, and it is that system which will become completely obsolete, I believe, in the early 1970's. The other manned bomber system depends on missiles and is no different from any other missile-based system."

McNamara said the proposal would be a manned missile system in the same sense that *Polaris* is a manned missile system. "But it is not a manned bomber system as the term is normally used or thought of. It is a missile; it is a manned missile system."

However, he added, it still has some of the same disadvantages mentioned in his earlier explanation of the *Skybolt* cancellation: "The bomber has to take off under most circumstances in order to survive," while an underground missile "can remain in its silo, or under the sea, and need not be launched until the same moment of time that the missile is launched from the bomber. So in that sense there is no flexibility introduced into our strategic systems by the use of a missile launched from a bomber . . ."

NASA Outlines Boston Center Plans

Officials stress that they're not raiding talent supply; prime goal is in-house competence; plan has high priority

by Michael Getler

BOSTON—NASA's proposal to locate a $50-million Electronics Research Center in the Boston area is gaining strong support from local industry—now that answers are forthcoming to some questions about the center's operation.

Of major concern to hundreds of electronics firms here are 1) the possibility that local engineering talent would be drained to staff the new center, and 2) how much new business to be generated by the center will be done in-house rather than being parcelled out to industry.

Some earlier press reports interpreted these questions as reflecting hostility within segments of local industry. To correct this view, many electronics executives here have recently made statements in strong support of the proposal. They define early queries regarding procurement and personnel as "legitimate business questions."

● **Not a raid**—When fully staffed, the center will include about 2000 persons. Of these, about 600-700 will be research engineers. Franklyn W. Phillips, chief of NASA's Northeast Regional Office here, told M/R these engineers probably will be acquired gradually over the course of the next 5-7 years, averaging about 100 per year. "A research staff," he notes, "doesn't get hired, it gets developed."

A few of these engineers may come from within NASA, says Phillips, "but the intention of the center is to augment the existing NASA talent with new people. The recruitment effort will be nationwide, not confined to New England. Whether or not there is an electronics research center, the manpower requirement just does not go away. We are not trying to decimate anybody's shop."

Phillips also points out that the center is actually very likely to hold a number of engineers in the New England area who otherwise might leave. "By the same token," he adds, "we also expect to lose some of our engineers after a period to local industry. This is not necessarily bad for us or for industry. The interchange of experienced personnel between government and industry is quite important in development of a broad viewpoint."

Concerning the in-house/out-of-house work ratios, Phillips reports, "we are now trying to work out these percentages. We do expect to generate a substantial contract program." Though exact ratios will be difficult—since the center, at best, will not begin to function in its new quarters until late in 1965—Phillips estimates that the facility will develop along the same business patterns as have NASA's Langley and Ames Research Centers.

New Space Corporation Forming in 'Hub City'

Complementing its growing importance in electronics research and development, Boston is also the scene of a unique corporate organization which, in various forms, has been attempting to get off the ground for several months.

To be called Advanced Technology, Inc., the organization is now seeking financial and technical support from nearly 400 electronics firms in this area, mostly smaller research-type companies. Eventually, with this support, the organization hopes to bid on government contracts, using the unified talents and resources of these firms to present a more formidable front.

Though earlier concepts of this type sought to create "a major prime contractor for the area," a spokesman for the new group said the firm would probably compete initially for study-type contracts with limited hardware involvement. He also said a move for incorporation could come within a few weeks and that a first bid would follow within a month—"though," he reports, "not much money is in the till so far."

Firms are being asked to chip in funds of $2000-25,000, based on annual sales, with the top figure applied to firms with more than $40 million in sales.

The group is backed by some of the top educators, financial interests, and industrialists in the Northeast. Dr. James R. Killian, Jr., of the MIT Corp., has been named chairman of the board, and the group is now seeking a president. M/R has learned that Dr. Joseph Charyk, AF under secretary who will soon take over as president of the newly formed Communications Satellite Corp., was approached for the job.

One of the major problems facing the group involves obviously competitive situations which could ultimately develop between the new corporation and some of the larger system-oriented firms in the area, who are now being asked for support.

Though many applaud the regional aims of the group, some government and industry sources interviewed by M/R tend to doubt the corporation's ability to reach a point where it can bid competitively on multimillion-dollar contracts with hope of surviving attendant management scrutiny by the funding agency.

Whether or not this new corporation does get into business, the immense preparation for this venture must be given the credit for a general awakening in the area to the need for new methods of best presenting regional capabilities to the AF and NASA. ■

"We expect to do work which runs from basic physics through development of very-high-risk system prototypes. Our intention is not to do production, nor to do all things within these areas."

● **More than procurement**—Though the center is bound to generate a significant amount of work which will need industry assistance a lot sooner than might have been the case without the center's impetus, Phillips stresses that the main concern is not procurement.

"The primary reason for setting up this center was the NASA conviction that they must have the ability and the in-house competence to reach their own independent judgment on matters of vital concern to the nation's space program. There is a definite need for a stimulus for space-oriented electronics research." NASA has estimated that about 90% of space system failures are electronic (M/R, Sept. 17, p. 42).

Because of the critical need for this competence, the Boston center holds a high priority in the broad NASA scheme and is generally assured of surviving if budgetary cuts are dealt to the space agency in the upcoming Congressional scrutiny of the entire FY '64 request.

● **Two-year study**—NASA recognized the need for improved electronics capability early in 1961, and later that year took a major step by creating the Office of Electronics and Control, headed by Dr. Albert Kelley, within the Office of Advanced Research and Technology. Kelley's office served as focal point for development of the center.

NASA insiders point out that the need for the center and the decision to go ahead with the proposal were made long before the choice of the Boston area as the locale. Dismissing reports of political considerations, a top NASA officer observes, "Boston was a pretty obvious choice."

No decision on exact location of the facility will be made until after Congressional budget action, which is not expected until about August or September. The center will be in the "Greater Boston area, as close as possible to the university-industrial hub."

Dr. Kelley, a native of this area, has often been mentioned as a likely bet to head the new center, if it is approved. However, an informed NASA official told M/R that the space agency will probably seek a director from outside NASA. No commitment on a director is likely before January, 1964.

● **First Plans**—Pending budgetary approval, the center in FY '64 will get $5 million for land acquisition and site development and about $3.5 million for operating expenses. FY '65 will include a request for construction funds, with work beginning late in Calendar '64. First facility will probably be available for occupancy after 12-16 months. Annual operating costs after completion are estimated at about $15-20 million.

Research at the center will focus on communications, data processing, computer operations, instrumentation, guidance and control. Plans include an extensive environmental test facility that will be made available to industry working with the center.

Establishment of the Boston center will turn the area into probably the most highly concentrated government-industry-university electronics complex in the world. Both Dr. Kelley and Phillips have already met with AF Maj. Gen. C. H. Terhune, Jr., and Brig. Gen. B. G. Holzman, heads respectively of the nearby AF Electronics Systems Div. and Cambridge Research Laboratories.

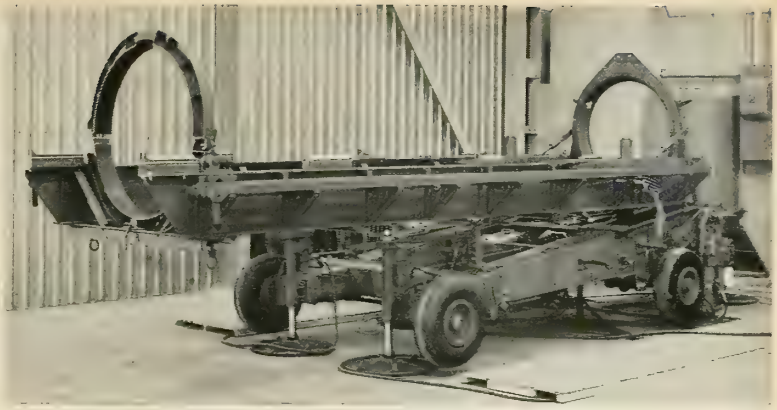
"There will certainly be an exchange of views between NASA and the AF here," Phillips reports, and liaison is under way to avoid duplication in various areas. NASA is now supporting work at AFCRL and at the neighboring Lincoln Laboratories of MIT.

Also under development here and expected to contribute to industry participation in R&D is the new MIT Center for Space Research, programmed for completion by late 1965. NASA has made a $3-million facilities grant to MIT for this center, with MIT putting up $1 million.

● **Regional office role**—Phillips' operation is also expected to grow in size shortly, reflecting addition of some ERC task-force planners and the emergence of clearer responsibilities for the office with respect to other NASA centers spread around the country.

Phillips' group is charged with aiding NASA in managing its program in New England, with providing guidance to New England firms in getting aboard space agency programs, and with keeping NASA informed of area capabilities. The office was opened last year, Phillips reports, because "NASA felt this area had a great deal of electronics competence. It was not an advance cadre for the Electronics Research Center."

The office now provides management monitoring and contract administration of work that is being done in New England under contract to NASA centers far removed from this area. This same relationship is not likely to apply to the Electronics Research Center, which will naturally be just as close to work being done by local firms. Phillips also emphasizes that not all contracts will go to local firms. ■



First Pershing ELGMT 'Broken Out'

FIRST PHOTO of initial Erector-Launcher, Guided Missile, Transportable (ELGMT) for the Army's Pershing tactical missile system to be shipped by Unidynamics, a division of Universal Match Corp., under "production breakout" from Martin-Orlando. Built at St. Louis, equipment was shipped 45 days ahead of schedule.

ASO Contract Award Due

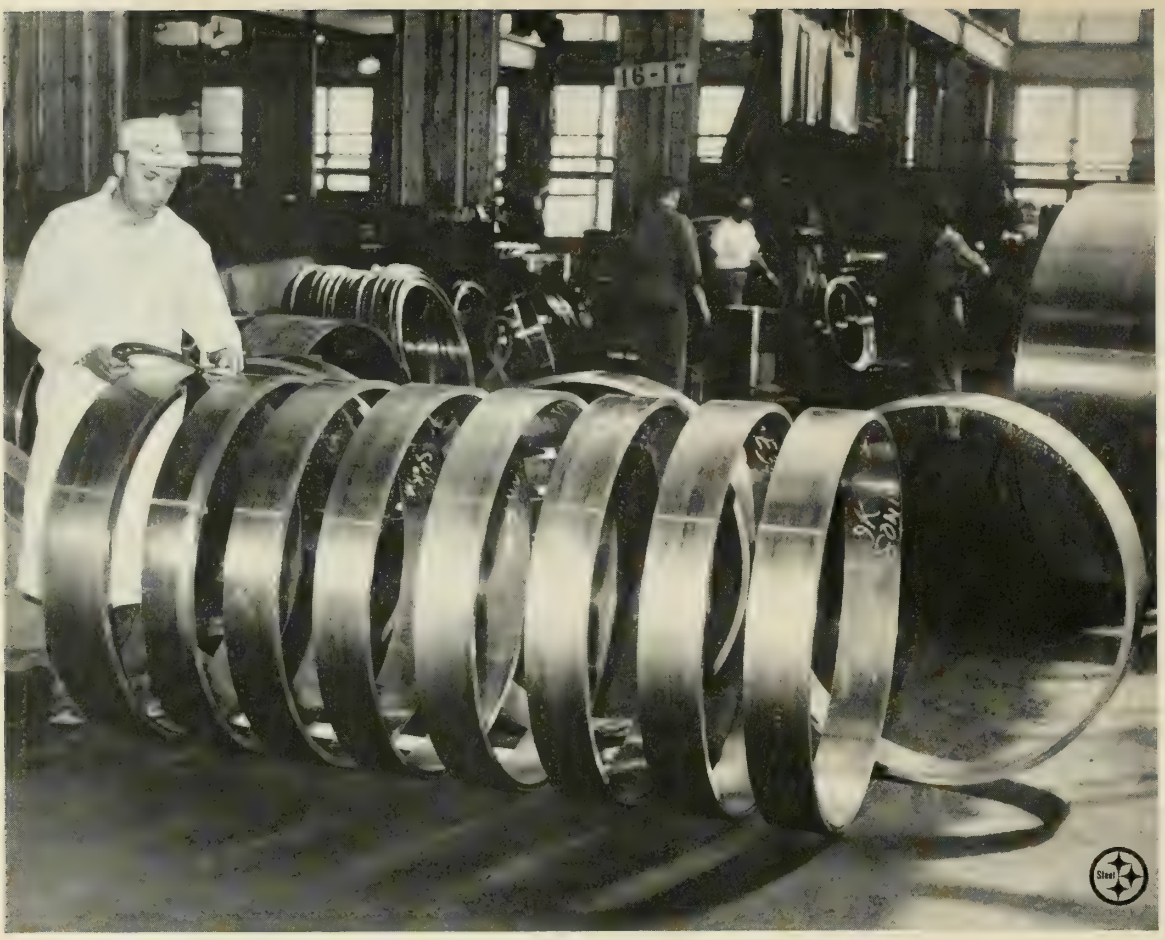
NASA expects to award a contract in mid-April for development of the *Advanced Solar Observatory (ASO)*.

Three firms—Space Technology Laboratories, Republic Aircraft Corp. and Ball Brothers—are competing.

All three recently completed feasibility studies of the spacecraft, to be launched at the rate of four a year beginning in 1966-67.

ASO will weigh 1000 lbs. and point experiments to a point on the Sun with an accuracy of five arc sec., NASA says.

NASA's Fiscal '64 budget request of about $12 million for the *Orbiting Solar Observatory* program will be used primarily to pay the initial costs for the advanced version. Cost of the program will total over $100 million.



Forged rings of 18% nickel maraging steel ready for shear spinning into solid fuel rocket motor cases. (Made by Standard Steel Division, Baldwin-Lima-Hamilton Corporation.)

The answer to high strength lightweight rocket cases ...18% Nickel Maraging Steel

A steel with yield strength greater than 240,000 psi and fracture toughness sufficient for rocket motor cases! That's what metallurgists at Wright Aeronautical Division of Curtiss-Wright Corporation needed for their recent missile case development program. After a thorough investigation of the newly developed maraging steels in their laboratories, they selected 18% Nickel Maraging Steel for these highly stressed parts. And this quality nickel alloy steel fully met their requirements.

18% Nickel Maraging Steel sheet has a yield strength over 300,000 psi, good notched tensile strength, and Rc hardness 53-55. These mechanical properties are developed by a simple "maraging" (martensite-aging) treatment at 900 F for three hours. There is practically no *structural or dimensional distortion*—parts can be finished to close tolerances *before* maraging. Hot and cold working properties (before maraging) are excellent. So are machinability and weldability. And the steel has the unusual feature of also being readily weldable in the maraged condition.

Missile case designers at Wright Aeronautical Division found 18% Nickel Maraging Steel well suited for high strength lightweight motor cases...not only for present size rockets, but those envisioned for the future. Perhaps this remarkable maraging steel at either the 200,000, 250,000 or 300,000 psi yield strength level may answer your materials problems. For complete information about this new alloy steel, write for the booklet, "Preliminary Technical Data on the Maraging Nickel Steels."

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ELECTRONICS

vania Delivers ASD Laser System

A laser communications system, which reportedly doubles efficiency of information transfer by light beam, has n delivered by Sylvania Electronic Systems to the Air ce's Aeronautical Systems Div. The two-channel optical em, employing a laser as its signal source, uses a techue called "polarization modulation" to produce received nals twice as powerful as those achieved in intensity ems. Transmission range is increased some 40%. The ıl signal power is usable with this approach instead of y half usually available because of the on/off amplitude iations normally employed. In the Sylvania system, infortion is placed on the carrier by varying the polarization the transmitted wave.

oftop Flights Used for Antenna R&D

A 14-ft. scale model of the *Saturn V* launch vehicle, ıng from a boom on the roof of North American's Space l Informations System Div., is being used to help deterıe antenna locations on the lunar launcher. The scale del receives test signals to permit performance analysis radio telemetry, communications and radio beacon annas. Purposes of the test are to determine both the design l positions of the *Saturn V* antennas.

icrominiature Brain Developed in England

The Mullard Co., a Britain-based arm of the Anglo-Dutch illips electronics combine, has delivered a microminiature ctronic "brain" to the Space Dept. of the Royal Aircraft tablishment, Farnborough. The unit measures 17 cu. in. th a weight of about 1.66 lbs., and contains 3438 comnents—1221 semiconductors and 2217 resistors and pacitors. The device, originally designed for the *Blue reak* missile, was three years in development. Spokesmen the firm claim a highly successful method of mass-procing thin-film circuits evolved in the program and that e British now know as much about the technology as the .S. does.

hrike Development Rapid

First *Shrike* anti-radiation missiles (including guidance) ed have all been built by the Naval Ordnance Test Center, hina Lake, Calif., except for one. That, using a prototype uidance system built by Texas Instruments, was considered ly partially successful. Two more *Shrike* missiles using I-built guidance were scheduled for launch last week. revious tests were said to have been so successful that TI ill be given a letter contract April 1 for pilot production f the radar-homing guidance system.

ADVANCED MATERIALS

CA Operates Plastic Laser

Traces of europium in fibers of polymethyl methacrylate roduce coherent pulses of intense crimson light when exosed to flashes of ultraviolet light. Developed at the RCA aboratories, the plastic laser operates in a liquid nitrogen ath. The energy from the ultraviolet light is transmitted by ıe plastic fiber to embedded chelates, which absorb the ıergy and transfer it to the europium atoms. The fibers ap the red pulse, sweeping it along the length of the fiber ıd stimulating other red flashes. The end effect is the production of a single pulse of coherent light bursting from the end of the fiber bundle. The achievement of laser action with europium in an organic polymer may point the way to a new family of lasers, say RCA researchers.

Refractory Metals Joining Program at Northrop

Northrop Norair will develop methods for joining columbium and molybdenum alloys into large, high-strength honeycomb sandwich panels through a proprietary radiant brazing system. The $435,000 AF Aeronautical Systems Div. contract calls for heat shield panels 18-in. square and structural panels 24 by 36 in., both flat and curved. Fabrication and brazing will be preceded by materials evaluation and diffusion bonding of honeycomb cores, then followed by testing and structural analyses.

Gemini Windows Detailed

The *Gemini* capsule direct-view ports will be eye-shaped, and will consist of three parallel flat panels of glass with space separations to inhibit heat transfer. Designed and built by the Corning Glass Works, the outer panel of each window will use a 96% silica glass to act as a thermal heat shield. The inner panel will be an aluminosilicate glass especially strengthened to protect capsule integrity. The center panel will also be 96% silica glass and act as a fail-safe factor by fulfilling both thermal and mechanical functions. The first set of panels has been shipped to McDonnell Aircraft, prime contractor on the two-man space craft.

PROPULSION

Hydrogen Engine Passes 28-Minute Firing

Pratt E. Whitney's RL10A-3 liquid hydrogen rocket engine operated for 28 continuous minutes in a recent sustained firing test. The run represents more than three times the single mission requirement for the RL10-powered *Saturn S-IV* flights scheduled for Cape Canaveral later this year. The same engine had been fired 19 min. on the previous day, and has chalked up 27 runs totalling 3350 sec. accumulated firing time.

Sparrow III Solid Motor in Production

Solid propellant motors for the Navy's *Sparrow III* air-to-air missile will be produced at Rocketdyne's Solid Rocket Div., McGregor, Tex., under a $6.1 million contract from the Bureau of Naval Weapons. The motor uses a free-standing grain concept combined with Rocketdyne's Flexadyne propellant. The advanced *Sparrow* has a 30% wider temperature range and an increase of about 50% in propulsive power over earlier versions of the missile.

SPACE MEDICINE

No Obstacle to Apollo Shielding

Continuing radiation-protection research in the areas of proton-materials interaction, environmental definition, depth dose rates, and bioeffects, is expected to have a major influence on the weight of the final *Apollo* capsule. E. J. McLaughlin, head of NASA's Environmental Physiology and Psychology Section, said the agency is "guardedly optimistic that we are progressing toward a satisfactory solution of the radiation-protection problem." He added that at present there appears to be no insurmountable obstacle.

Air-Breathing Boosters Gain Favor

Space agency spokesman sees prospect of cutting vehicle costs, adding payload; Briton says vehicle could launch 50-ton satellite

by William Beller

AIR-BREATHING BOOSTERS for space vehicles are winning increased acceptance at NASA headquarters and Marshall Space Flight Center as a means of bringing launch vehicle costs down and increasing payload capacity.

A high-ranking space agency official reports that in-house studies of NASA's Hypersonic Research Vehicle (HRV) show that using the air-breathing booster as a first stage, followed by a rocket second-stage, "has a lot of merit." "This was not the belief around here a year ago," he added.

Present thinking is that the HRV would have an orbital mission—although the details won't be spelled out until in-house studies are completed. At that time, it is expected, out-of-house studies will be contracted for, possibly followed by design contracts, with a flight version of the HRV contemplated for completion in the early 1970's.

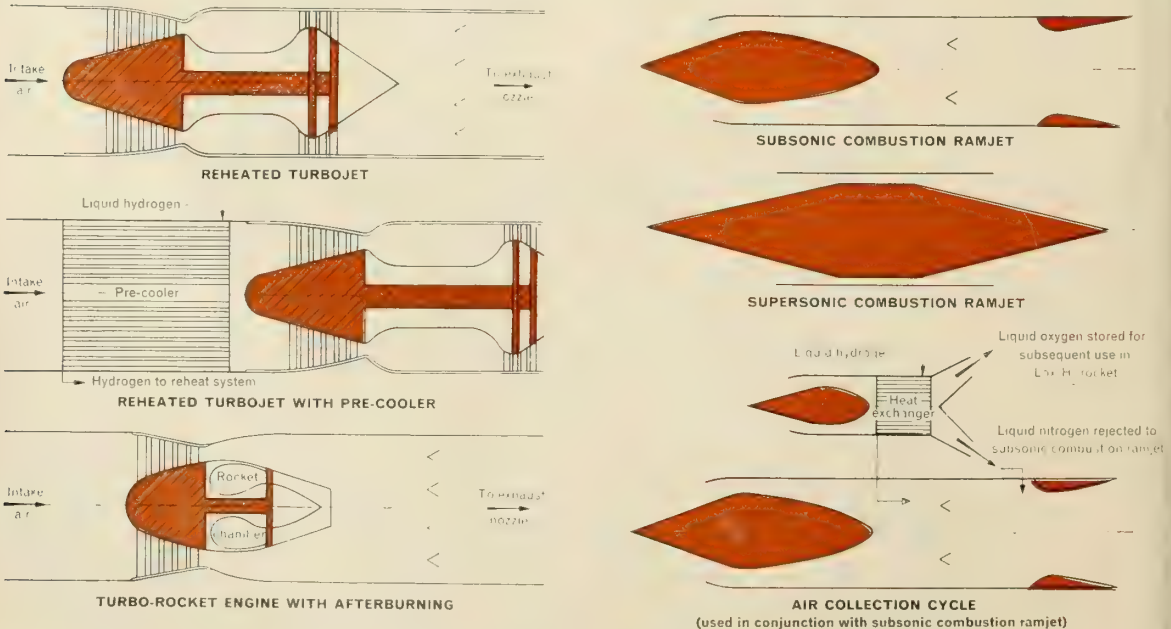
Evidence of NASA's interest in air-breathing boosters is the $3 million the agency says it will spend this fiscal year to evaluate the practical possibilities of winged hypersonic flight powered in part by air-breathers.

NASA says aerodynamic configurations for this purpose will have very large air inlets, bodies of very large volume, and abnormally small lifting and control surfaces. Preparations will also be made during the fiscal year for flight tests to validate ground-based data on heat transfer, pressure distributions, skin friction, and control effectiveness.

● **ASP to use air-breathers**—The NASA-USAF program for an *Aerospace Plane* (*ASP*) definitely envisions using an air-breathing booster (M/R, Aug. 27, 1962, p. 12). John Stack, former director of NASA's Aeronautical Research Program, told the House Space Committee that in the Mach 0 to 3 range, the operational mode of *ASP* would be that of a turbofan engine of the most familiar type, used with JP fuels or probably hydrogen.

"For the Mach number range above 3, the type of powerplant would change from a turbofan type to a ramjet, continuing probably to Mach numbers of 8 to 10," Stack said. "During this phase of the operation, oxygen would be collected by piping air from the duct ahead of the burner to a complex system which would liquefy the air, reject the nitrogen, and store the remaining oxygen as liquid in a tank.

"At the end of the collection cycle and at Mach numbers of the order of 8 to 10, hydrogen and oxygen would be burned in a rocket which would ultimately carry the vehicle to orbital



Six Air-Breathing Engines Suitable for Space Boosters

speed." Stack added that the turboram rocket concept is, in essence, a new technology, but "it will represent significant advancements in the state-of-the-art."

It is not yet clear whether *ASP* and the projected HRV will be separate endeavors or ultimately will be merged into one because of their costs. A NASA spokesman emphasizes, however, that the HRV will have "general" hypersonic missions, whereas *ASP* will be designed to fill specific USAF needs.

● **50-ton satellites**—For both economic and technical reasons, British and French firms are actively studying the possibility of launching satellites with the help of air-breathing boosters. While details of this approach are for the most part classified in the U.S., the foreign interests are freer in their discussions.

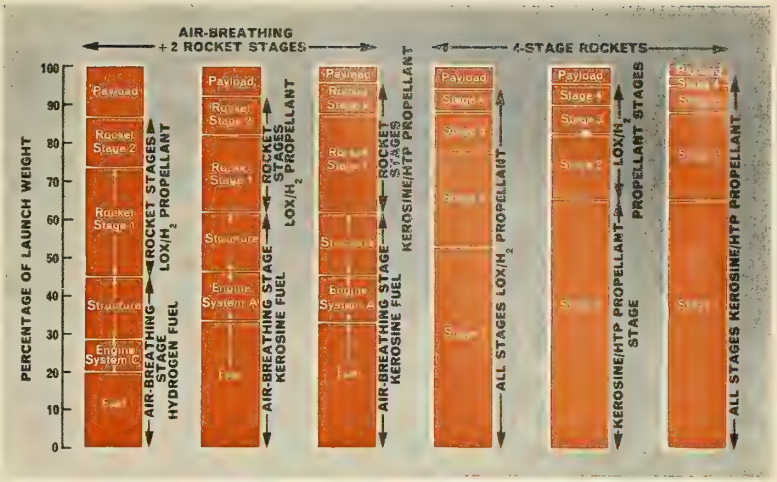
A British engineer, for instance, states that advanced forms of air-breathing engines could launch satellites weighing 50 tons. He says, furthermore, that such engines could bring a fourfold increase in present orbital payloads.

P. J. Lane of Bristol Siddeley Engines Ltd. documented his views in a paper read recently before the Astronautics and Guided Flight Section of the Royal Aeronautical Society. The paper was subsequently abridged in the *Bristol Siddeley Journal*.

Lane's studies show that very large gains in payload can be obtained if the first stage of a satellite booster is accelerated by air-breathing propulsion. He says that for maximum efficiency, this stage should operate up to a speed between Mach 10 (6500 mph) and Mach 14 (9000 mph), the remainder of the acceleration being provided by a two-stage rocket system.

Prime reason for the gains is the large specific impulse an air-breathing engine has in the low Mach number region—about 3500 sec. at Mach 2 for a hydrogen-fueled ramjet.

"To impart to the payload 20% of the orbital velocity, the rocket engine requires the expenditure of about 37% and 53% of the launch weight for hydrogen- and kerosene-fueled rockets, respectively," he says. "At the same time, the kinetic energy of the payload reaches



COMPARISON of stage and component weights for satellite boosters.

only about 4% of its final total. The air-breathing engine can achieve the same kinetic energy for fuel consumptions of 3% (hydrogen) or 7.5% (kerosene) of the launch weight."

Because air density and, consequently, oxygen density falls off with altitude, and the specific impulse or ramjet engines decreases quickly and almost linearly after about Mach 2, the air-breathing stage should be terminated before its fuel consumption becomes larger than that of the rocket stages.

● **$150/lb. in orbit**—If a speed of at least Mach 10 can be achieved with an air-breathing first-stage, it should be possible to reduce the launch weight for a given payload by 75%, Lane says.

A cost of about $150 per pound of satellite in orbit may be obtained, compared with the $600 which is the current aim of the advanced U.S. rocket projects.

He suggests that for speeds below Mach 1.5, the most suitable engines are the turbojet, with or without pre-cooling, or the turbo-rocket. "Between Mach 1.5 and Mach 7 the reheated or pre-cooled turbojet is still suitable for the lower part of the range, while the ramjet with subsonic combustion, with or without the help of an air-collection system is suitable for the higher speeds."

Lane agrees with U.S. authorities that above Mach 7 the ramjet with subsonic combustion soon reaches its limit and "the ramjet with supersonic combustion is left with no rival."

The pre-cooled turbojet and turbo-rocket are relatively modern concepts and perhaps are not too widely known, particularly the first engine. Here, liquid hydrogen—stored at a cryogenic temperature—is used as a fuel and also as a coolant "to reduce the temperature of the incoming air in a heat exchanger at the front of the reheated turbojet (turbojet with afterburner)."

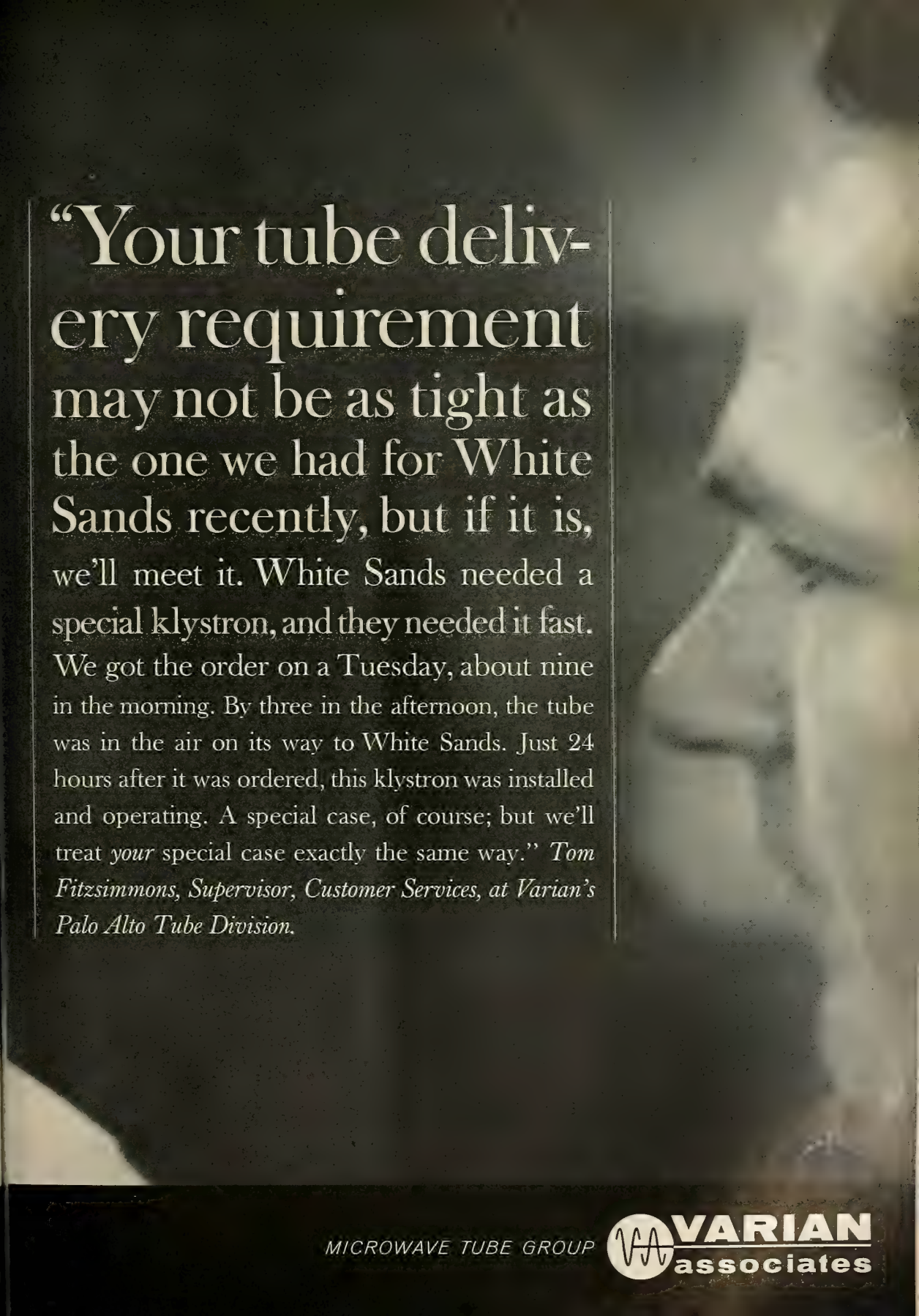
In the turbo-rocket, a small rocket motor drives a turbine which, in turn, drives a compressor. This system is said to give a high thrust for a low weight at take-off and low supersonic speeds. Above Mach 1.5, "the turbo-rocket can also operate as a subsonic combustion ramjet with the compressor by-passed or windmilling," Lane says.

Ramjets with subsonic combustion are operational, specifically in the *Bomarc*. Ramjets with supersonic combustion, however, are still in the study and research stage. Progress made on this powerplant is a pacing factor in advanced missile concepts and it has

ENGINE MACH NUMBER RANGE	GROUND-LAUNCHED BOOSTERS				AIR-LAUNCHED BOOSTERS
	System A	System B	System C	Air Scoop Cycle (Typical example)	
Mach 0 to 1.5	Reheated turbojet	Pre-cooled reheated turbojet	Turbo-rocket	Turbo-rocket	Propulsion as for adapted supersonic aircraft
Mach 1.5 to 4.0/5.0	Reheated turbojet plus subsonic combustion ramjet	As above plus subsonic combustion ramjet	Above used as a subsonic combustion ramjet	Above used as a subsonic combustion ramjet	Subsonic combustion ramjet
Mach 4.0/5.0 to 7.0	Subsonic combustion ramjet	Subsonic combustion ramjet	As above	As above, plus the air-scooping cycle	As above
Mach 7.0 to limiting speed	Supersonic combustion ramjet	Supersonic combustion ramjet	Supersonic combustion ramjet	Supersonic combustion ramjet	Supersonic combustion ramjet



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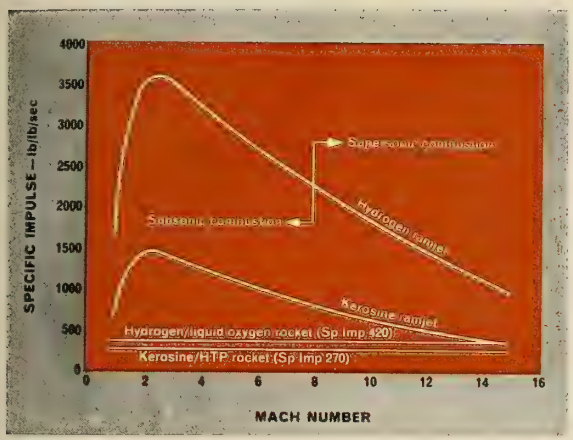
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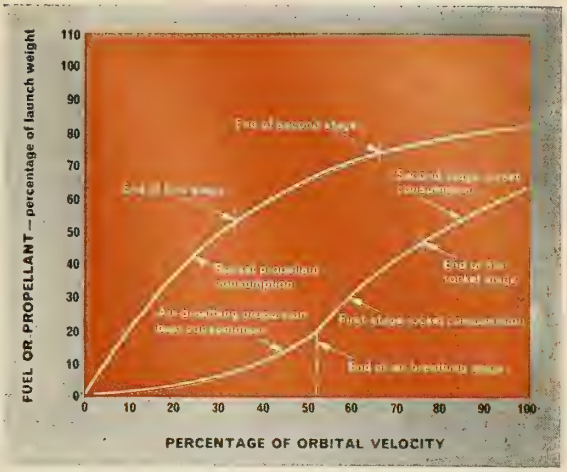
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LEFT: *Comparative specific impulses for ramjets and rockets.* RIGHT: *Propellants consumed by all-rocket and mixed-propulsion vehicles (air-breathing booster, hydrogen fuel; rocket booster, hydrogen-oxygen propellants).*

been the subject of several recent classified meetings. When such a powerplant is devised, it will be suitable for speeds up to at least Mach 14.

● **Combination of engines**—At least three modes of operation probably will be needed by an air-breathing booster propelling a payload from zero to Mach 10. The first mode calls for a turbojet or a turbo-rocket; in essence, these are about the same. The second mode calls for a subsonic combustion ramjet; the third, a supersonic combustion ramjet.

Lane compares a number of launching systems on the basis of payload in a 300-mi. circular orbit expressed as a percentage of total launch weight. He chooses as a typical all-rocket system a four-stage booster using hydrogen as a fuel in every stage. He says this rocket when ground-launched would achieve a payload of 6% (of launch weight) and is well ahead of any booster system proposed in NASA's present program.

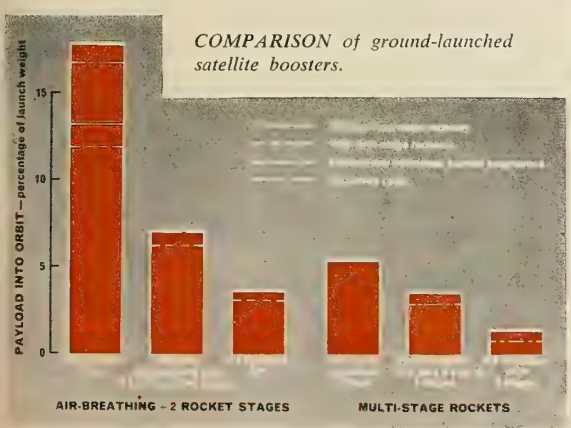
"If the propulsive system consists of a turbo-rocket and a ramjet with subsonic and supersonic combustion phases, a payload of about 13% is possible," Lane says. He points out that the best result obtainable with a similar system using kerosene fuel in all stages is about 4%. "In this case the air-breathing stage would consist of a reheated turbojet followed by ramjets with subsonic and supersonic combustion."

When an air-collection system is used—as in the *ASP* concept and Marquardt Corp.'s *LACE* concept—the best hydrogen-fueled air-breathing engine system reportedly will bring a further improvement in payload—to more than 18%.

To get the high accelerations needed for a boost vehicle and to maintain a minimum weight, it will be necessary for air-boosted vehicles to fly faster at lower altitudes than similarly constructed cruise vehicles. The boosting vehicle, for instance, would reach a flight speed of 12,000 fps at about 110,000 ft., compared with about 140,000 ft. for the cruise vehicle.

This higher speed at lower altitude will mean higher thermal stresses, but Lane feels that they will last only a short time and can be effectively resisted by techniques such as ablation and evaporative cooling.

Lane sees the air-breathing system taking the form of a delta-winged aircraft with the propulsion machinery underneath and the rocket stages mounted on its back. "When the aircraft has reached a speed of about 12,000 fps at 100,000 ft., the rocket stages would be slipped." ■



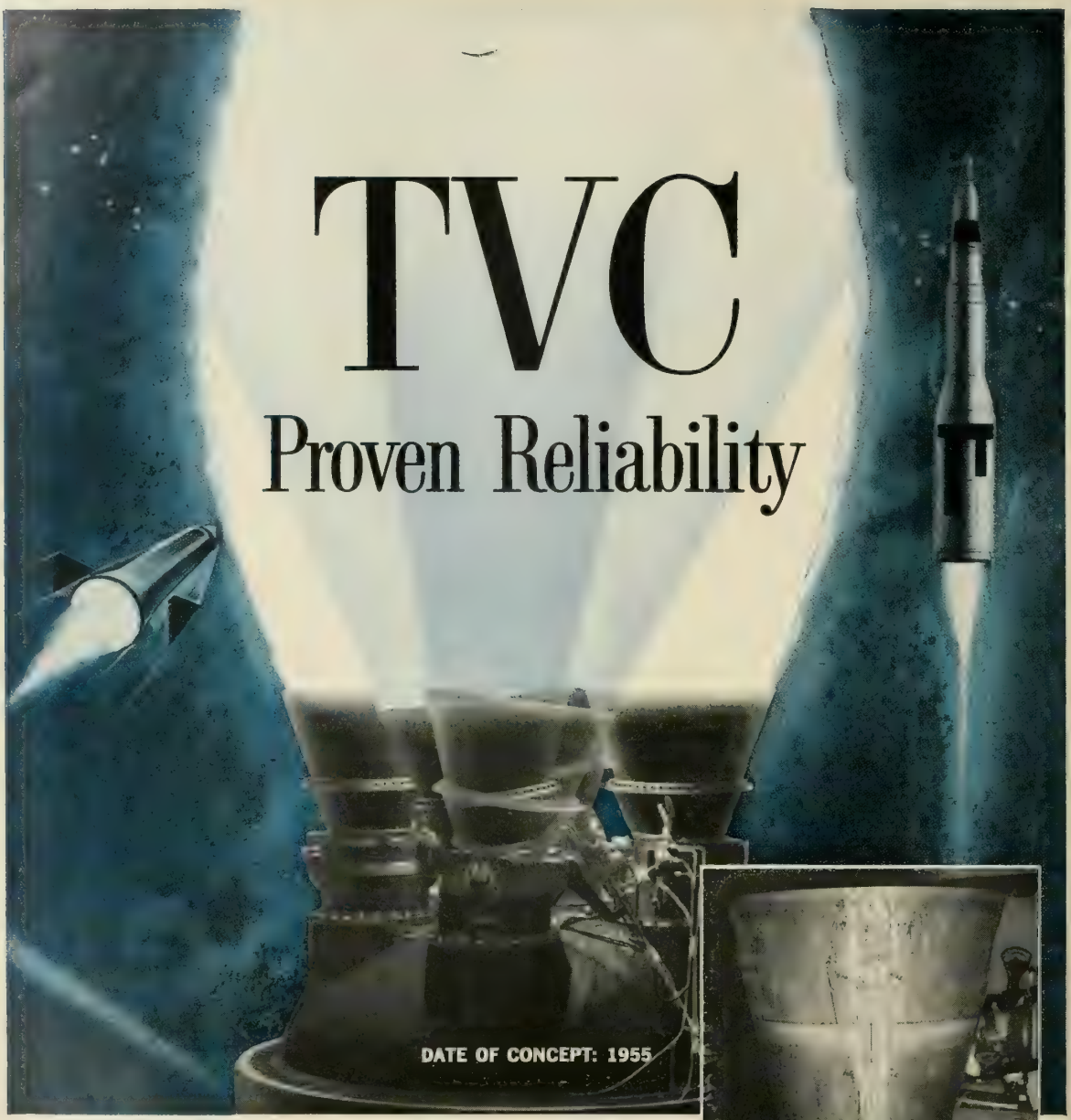
COMPARISON of ground-launched satellite boosters.



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NAA Demonstrates Laser Modulator

Device used with helium-neon laser transmits TV image within laboratory; beam pointer development disclosed

FEASIBILITY of a laser modulator using a modified Twyman-Green interferometer principle has been demonstrated by scientists in North American Aviation's Space & Information Systems Division, Downey, Calif.

A laboratory model, the company claims, has produced a 1.7-mc bandwidth at 40% modulation. Requiring only two watts of power, the interference modulator was used with a helium-neon laser to transmit a television image satisfactorily over a short distance in the laboratory.

At present, the optical modulator weighs about four pounds. Advanced, microminiaturized units, measuring about one cu. in., now are being designed, one official said.

This first laboratory model has been in operation for over six months and was used recently to transmit messages a distance of five miles.

Principle application presently conceived for the device would be for use with an optical communications system between spacecraft and the Moon or between space vehicles in orbit. The device, NAA says, will permit development of small, lightweight equipment with relatively small antennas.

Also, the company points out that the highly directional characteristics of a laser beam would inherently provide transmission security.

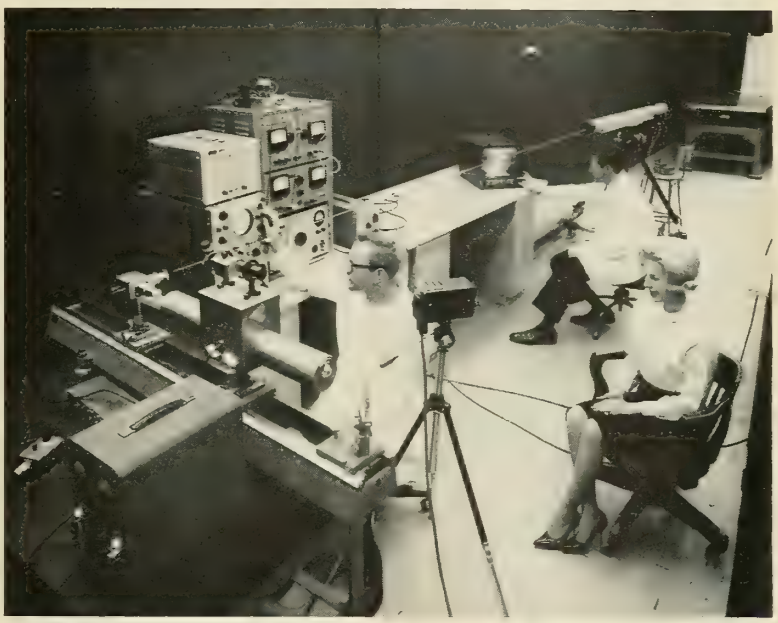
Concurrently with its announcement of the modulator development, NAA also disclosed its successful building of an electronic beam pointer.

The pointer would be required for precise orientation of antennas in space. Accuracy of the pointer is claimed to be of the order of "several degrees of arc."

The pointing device, division spokesmen said, reflects a coherent light beam from electronically controlled piezoelectric surfaces to keep the transmitted beam on target.

The new modulator employs the collimated and monochromatic characteristics of a helium-neon gas laser beam.

The incoming beam is first focused and then split into two separate beams by a 50% transmitting-50% reflecting mirror. Each beam is then reflected off mirror surfaces deposited on electro-mechanical piezoelectric transducer elements. These elements, said a company official, are electrically driven by the desired modulating signal, producing a piston-like motion to the mirror surfaces. This results in a variation of the two optical path lengths. A maximum difference of these path lengths for a given driving voltage is obtained by applying it exactly 180° out of phase.



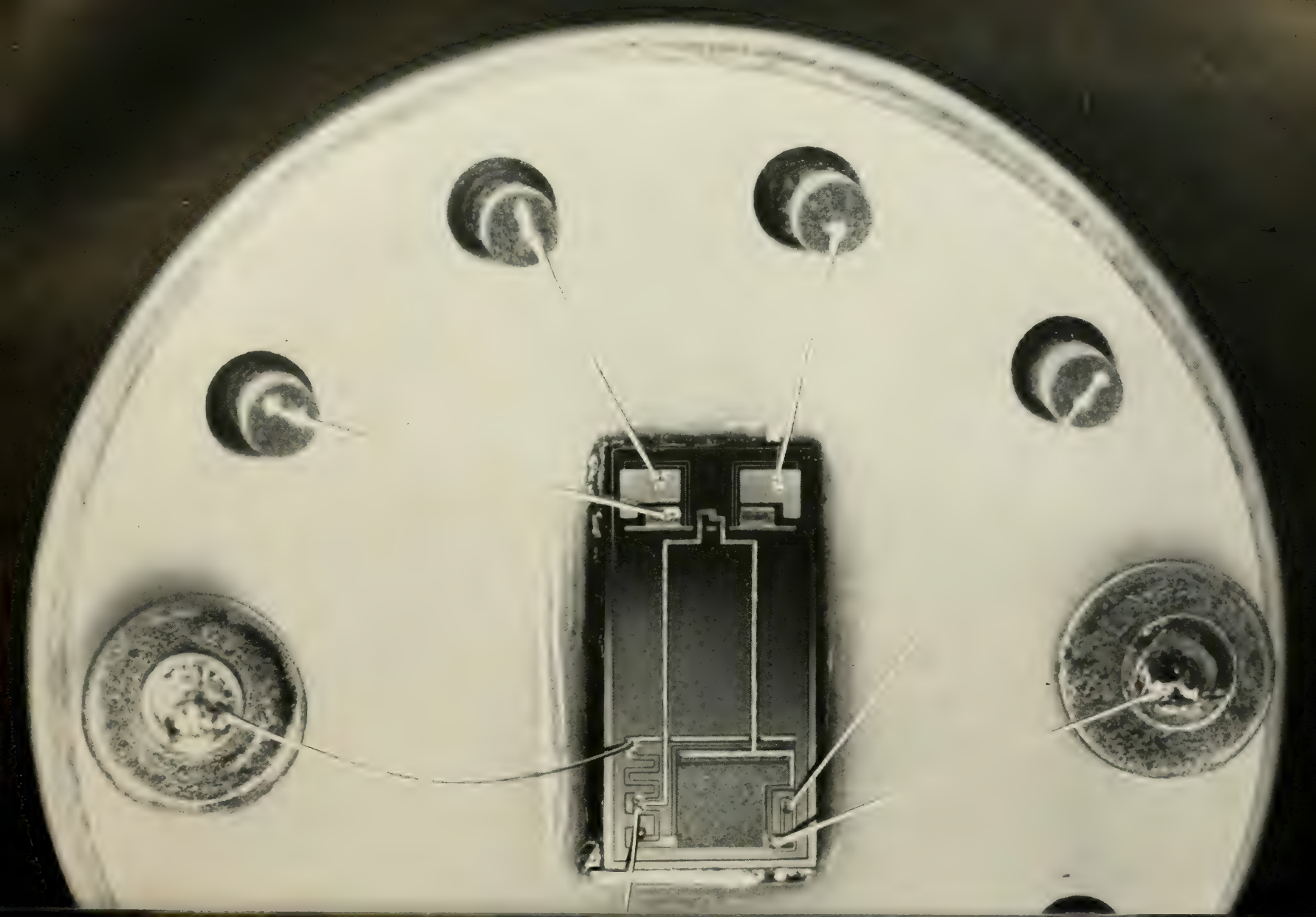
IN NAA DEMONSTRATION, continuous beam of light (left) generated by a helium-neon gas laser and directed into a hand-size "optical modulator," carries a television image. Light is directed by a new beam-pointing technique into the telescope-like optical receiver (rear right) where it strikes a photo cell, is converted into original TV signals and relayed to the picture tube. North American's Space and Information Systems Division says the simple, rugged and compact optical modulator is the key to applying the laser to space communications.

Recombination of the two reflected beams produces either constructive or destructive interference, causing the resultant beam intensity to vary in proportion to the modulator signal.

● **Key units**—The piezoelectric transducers are said to represent the most critical element of the modulator. By converting an electrical signal into mechanical mirror movement, it is possible to cause a controlled variation between the two optical path lengths.

To achieve 100% modulation with one moving crystal, the total movement of the reflecting surface must be at least one-quarter the wavelength of the laser beam. Since displacement of the piezoelectric element is directly proportional to the applied voltage, it becomes desirable to move both elements 180° out of phase, thus producing the instantaneous maximum path length difference (a displacement of only one-eighth wavelength movement for each transducer).

Analysis of available transducer materials, the company says, has shown that ceramic has the desired properties. Since the front face of these ceramic discs must act as reflecting mirrors in the interferometer, they are polished to near-optical flats and coated with a metallic film to serve both as reflectors and as electrodes. ■





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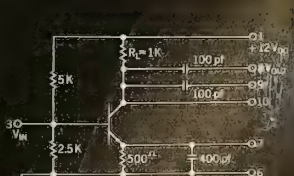
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POLARIS A-3 first-stage segmented aluminum mandrel in its handling fixture.

advanced materials

Aerojet Moves Into Basic Glass

Purchase of Houze R&D facility rounds out capability in filament-wound structures

by John F. Judge

AEROJET-GENERAL CORP. is moving swiftly into basic glass fiber technology with the acquisition of the complete research and development facilities of the Houze Glass Corp.—including furnaces, personnel, patents and technical data.

The entire facility and its personnel are being moved from the Houze site in Point Marion, Pa., to Aerojet's Structural Materials Div. in Azusa, Calif. The new operation will be pulling fibers before the end of this month.

Aerojet's purchase reflects its belief that the relatively low production potential in aerospace hardware is causing a lack of research in this area of glass fiber technology. The firm is one of the industry leaders in filament-wound structures and currently produces glass-reinforced motor cases for the first stage of the *Polaris A3* missile.

About 2000 sq. ft. in the Azusa plant will be used initially. The equipment involved here includes two single-hole furnaces, a 204-hole, marble-type furnace and four test pots of 400-gram capacity. A creel and waywinder will be added to provide a capability for 20-end rovings.

One of the single-hole units will be housed in an atmosphere-controlled area—several cuts above the usual missile "clean room" conditions.

Initial plans call for the three Houze researchers to be joined by several Aerojet engineers and supporting technicians. Other personnel will be drawn from the non-metallics research department as the operation grows. Additional equipment will also be supplied as required to provide a complete capability in glass fiber research.

The general problems to be tackled include the development of improved, very-high-strength and high-modulus glass fibers. Strength retention from bushing to applications, fiber coatings, bushing temperatures and other routes will be explored.

Although the entire operation is being supported by corporate funds, Aerojet spokesmen expect to seek research contracts in the glass fiber field. The installation gives Aerojet a complete capability in filament winding—from basic materials to finished products. The firm's polymer chemists have long been working on the resin side of glass-reinforced plastics.

The cost of the new facility was not disclosed, nor were any details of the Houze purchase.

● **A-3 Case Production**—The other end of the Aerojet manufacturing spectrum in the field of filament winding is represented in the *Polaris A-3* first-stage motor chambers.

Aerojet uses collapsible, segmented aluminum mandrels in case production, since the design configuration is fairly stable. These mandrels are more expensive than the built-up, disposable units used in development programs, but the initial cost is justified on the basis of re-use.

The mandrel is designed so that its assembled configuration is slightly smaller than the inside contour of the completed case. The difference is made up by a thin wall of plaster swept over the mandrel to the final inside contour.

The insulation is generally die-molded in production runs, replacing the hand layup method employed during the development phases. Die molding has the advantages of closer tolerances, better densities and reproducibility.

The entire mandrel assembly process and insulation is illustrated at the top of page 35. On the far left is the segmented aluminum mandrel, next is the same mandrel after the plaster sweep and application of forward boss insulation. The third unit shows the completely insulated mandrel and the last is the mandrel with its final coating, ready for the winding process.

Aerojet uses a vertical winding machine in the process, since the vertical mandrel position eliminates the possi-

bility of its being deflected by its own weight.

The vertical winder illustrated uses eddy-current-type tension devices to keep the stress levels within design tolerances—constantly maintaining tension within ±0.5 lbs. The eddy current devices provide positive, uniform control under extreme rate-of-feed variations.

In operation, a rotating arm passes over the forward and aft poles of the mandrel while it rotates—supplying the longitudinal pattern needed to obtain strength in the longitudinal direction. The strands of roving are fed through a series of rollers to achieve the required tape width.

Hoop strength is supplied by applying roving, in the form of tape, circumferentially around the mandrel by means of a transversing carriage. In both cases, the movement of the tape-feeding apparatus is synchronized with the rotation of the mandrel.

● **"B" staged resin utilized**—Preimpregnated roving is used extensively in the *Polaris* case manufacture. The finished roving is made in large quantities at a specially designed facility under rigid quality-control conditions. The dry roving is passed through a resin impregnation system to produce a specified percentage of resin content.

The roving then passes through a heat source where it is "B" staged or partially cured, and wound back on rollers under controlled tension. The preimpregnated roving is stored in sealed containers at low temperatures until ready for use. The usual quality control sampling is carried out.

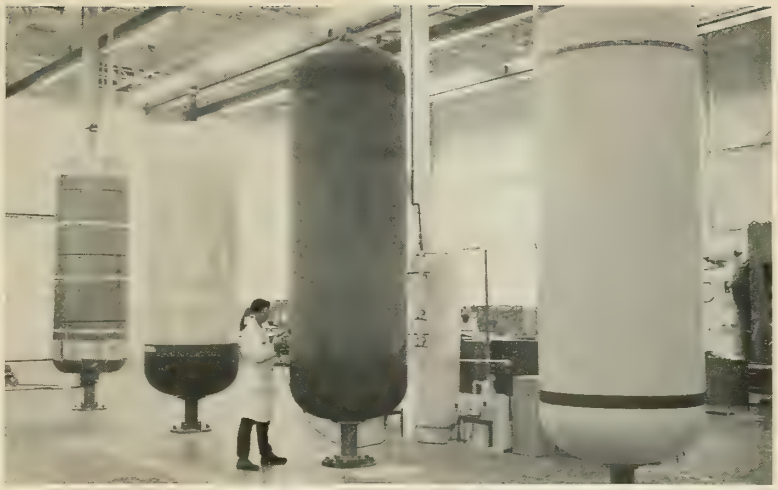
After the case has been wound, it is transferred to a vertical curing oven where the "B" staged resin/glass combination receives its final cure. The case is slowly rotated in the oven to assure even heat distribution.

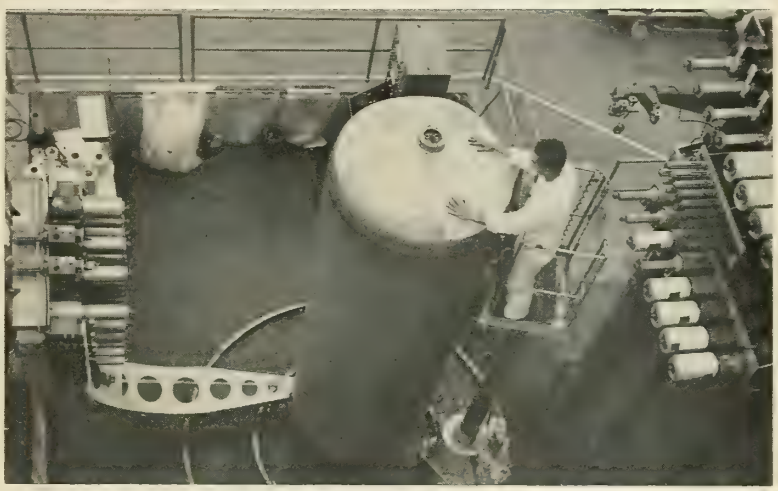
After final cure, the aluminum mandrel is carefully disassembled and removed through a port opening. The plaster sweep is removed next and the insulation surface cleaned.

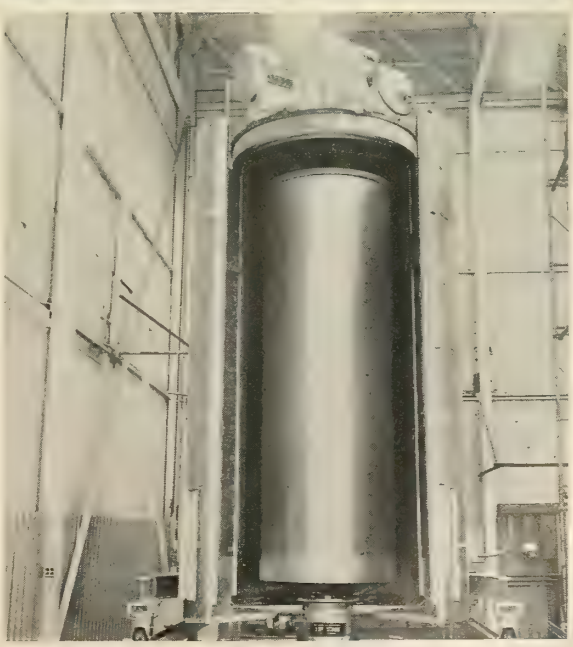
To minimize deflection problems, Aerojet performs as many of these operations as possible in the vertical position. In addition, this procedure minimizes floor space and cuts down the handling operations.

The incorporation of an extensive glass-making operation on a research basis considerably augments Aerojet's marketing capability in the relatively undeveloped field of filament-wound and other glass-reinforced structures.

While filament winding has its limitations, most of these can be overcome in the process of designing the end structure, and Aerojet now controls all of the basic inputs to reliable, glass-wound hardware. ■







VERTICAL winding machine (above) shows eddy-current devices for both hoop and longitudinal winding. Finished case is cured in vertical oven (right).

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Syncom Found by New R&RR Tracking System

NASA's Goddard Center used data obtained to predict satellite's orbital position within 6 minutes of arc

by Charles D. LaFond

THE RANGE AND Range Rate Tracking System developed for *Syncom 1* is being credited by NASA officials with having supplied the data used to locate the silent spacecraft.

This is believed to be the first unclassified use of such a system to track a satellite.

Syncom 1, the first of a series of experimental communications relay satellites to be placed in a 24-hr. stationary orbit, went dead during injection from the transfer orbit into the planned synchronous orbit.

Using data obtained by the R&RR system, NASA's Goddard Space Flight Center predicted the actual orbital position of the vehicle with an error of only six minutes of arc.

Based on the photographs of *Syncom* obtained in the past few weeks, a refined orbit has been determined. However, when compared with the early predictions, residuals averaged better than 15.5 meters in range and 0.045 meter/sec. in range rate, said GSFC scientists.

● **Syncom R&RR system**—The *Syncom* Range and Range Rate Tracking System was developed by Space Technology Laboratories for Goddard on a crash basis, beginning in September, 1961. The contract called for it to be operational in roughly nine months.

Major objective of the system was to permit early and accurate determination of the transfer orbit. From this NASA could determine the optimum time to fire the apogee kick motor for the required synchronous orbit. Accuracy goals included: Range, ±15 meters, Range Rate, ±0.1 m/sec.

The approach demanded that existing communications equipment be used wherever possible and that no subsystems be introduced in the satellite. Only a minor circuit modification of the spacecraft's transponder was required. As one NASA scientist put it, "this was one time we made an onboard improvement adding zero weight and zero power."

The *Syncom* was provided with two separate transmitter/receiver subsystems. One was designed for use in the communications relay experiments after achieving the synchronous orbit. During launch phase, however, it was to serve as transponder and beacon for range and range-rate determinations.

The other subsystem, similarly redundant, was provided for telemetering and command signals.

Five racks of equipment comprised the total added ground facilities at each station.

In the *Syncom* system, range is determined by measuring the transit delay of a series of modulated tones impressed on an RF carrier. A basic 100-kc tone is used from which side tones, stepped down by a factor of 5, are employed to resolve phase ambiguity.

Range rate is determined by measuring the Doppler shift of the carrier signal.

The ground transmitter operates at 7400 mc with a 20-kw output through a 30-ft.-dia. paraboloidal-reflector antenna. (Only 10-kw was used for the *Syncom 1* experiment.)

The transponder in the satellite translates the received signal to 1815 mc and to 1820 mc (the latter for autotrack purposes) and returns the signals with a two-watt output.

On the ground, the received signals are directed to a parametric preamplifier and then into two phase-locked receivers. The receiver outputs are then processed by a Doppler extractor and a range extractor.

Redundant outputs are provided on punched tape for subsequent teletype transmission to Goddard for orbit prediction.

● **Syncom 1 launch**—On Feb. 14, *Syncom 1* was launched from Cape Canaveral by a *Delta* three-stage boost vehicle. It was planned to carry the spacecraft into an elliptical transfer orbit with an apogee of 19,312 n.mi. and 150-n.-mi. perigee.

The third stage was to have been spin-stabilized prior to its ignition.

At the transfer-ellipse apogee (the



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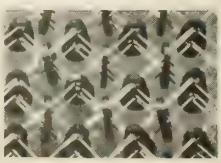
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spacecraft then located over S. Africa), an apogee motor in the satellite was to be fired either automatically by an outboard timer or earlier by ground command signal if an optimum firing time had been calculated.

The motor, providing 20 sec. of thrust, would inject the spacecraft into a nearly synchronous circular orbit.

The command, telemetry, and range and range rate ground facilities were located at Lakehurst, N.J., and aboard the USNS Kingsport, anchored in Lagos Harbor, Nigeria. A backup station was located at Fort Dix, N.J.

Twenty minutes after launch, the first R&RR signals were obtained over a 15-minute period by the Kingsport station. Minitrack data were obtained at Johannesburg, S. Africa.

Again, at liftoff +3½ hours, another 15-minute period of data was collected. During this coast period, about 1½ hrs. of minitrack and telemetry data were received at Johannesburg, and a 5-min. communications test was performed from the Kingsport. Voice, music, and teletype transmissions were all relayed.

During this time, Goddard's Theory and Analysis Office, Data Systems Div., used eight blocks of R&RR data. Each block consisted of 32 range, 32 range rate, 4 azimuth, and 4 elevation measurements. From these samples of data, almost the exact transfer-orbit path was established. Goddard scientists then corrected the apogee kick motor firing time by 12 minutes.

The firing command was transmitted from the Kingsport, 20 sec. of telemetry data were received, and the satellite became silent.

At this time, it was not known that the kick motor had operated.

Goddard theoreticians, assuming the motor had fired, predicted two possible synchronous orbits based on assumed velocity errors of plus and minus 100-ft./sec.

These predictions were used to provide pointing data to several tracking stations and observations within "sight" of the satellite.

At midnight on Feb. 24, the first photograph of *Syncom 1* was obtained by the Boyden Observatory at Bloenfontein, S. Africa, using a Super Schmidt telescope and camera.

Additional sightings were made by Boyden on Feb. 25 and Mar. 2. *Syncom* has also been seen with the large telescope at Canberra, Australia.

It has been determined that Goddard's predictions (using the higher velocity) were only 6 min. of arc in error.

At present, the satellite is slowly drifting eastward at a rate of 2.8° per day. Its orbit is low—about 22,000 n.mi., and the orbital period is 23 hrs. 45 min. ■

Wetzel Discusses Small Business

Small business could benefit greatly from a greater awareness and understanding of the regulations and policies of the Small Business Administration and the small-business operations of the military services.

This is the conclusion of Harry H. Wetzel, executive vice president of the Garrett Corp. Wetzel bases his opinion on his firm's purchasing experiences during 1962—when Garrett spent more than $1 million for raw materials, parts and components and issued 175,000 purchase orders to 6000 firms in 30 states, the District of Columbia and Canada.

About 75% of these 6000 firms—those that collectively received 62.6% of the Garrett purchase dollars—were small-business operations, Wetzel reports.

A Garrett survey of more than 100 buyers produced the following advice for small-business management:

— Consult the Small Business Administration and military small-business specialists to determine which companies can be categorized as members of "small business."

— Learn the requirements for being listed on a customer's "approved small supplier list."

— Keep up with technological developments by reading pertinent trade publications.

— Be familiar with government specifications covering fabrication, assembly and quality control.

— Back up each sales approach with a personal interest in prompt deliveries and high quality.

Wetzel said the survey indicates that small business is more active in soliciting contracts and orders than is big business. Of those salesmen soliciting business from Garrett in 1962, 91% represented small firms. However, only 54% used this factor in their sales approaches, Wetzel said.

Industry Facilities

North American Aviation, Inc., has completed purchase of 61 acres of Conejo Valley, Calif., property for its new Science Center facility. The purchase, pending for more than a year, had been delayed by litigation to block NAA's use of the property. A recent court decision ruled in favor of the firm.

NAA's Science Center—said to be among the few on the West Coast devoted by an industrial firm purely to fundamental research—will be designed by Albert C. Martin & Associates. The 110,000-sq.-ft. facility will cost about $6 million, NAA spokesmen estimate. . . . *Janco Corp., Burbank, Calif., producer of rotary and solenoid-operated switches, has completed an expansion of its facilities to provide 30,000 sq. ft. for production, engineering, drafting, sales and administration functions.* . . . Louisiana, Mississippi, Alabama, Georgia, Florida, Tennessee, and North and South Carolina will be served by a new branch office of Pyles Industries, Inc., Detroit manufacturer of fluid pumping, metering, mixing and dispensing equipment. The office, located in Atlanta, will provide sales and distribution facilities for the company's entire line. . . . *Now in full operation at Redlands, Calif., is a new nondestructive-test laboratory of Lockheed Propulsion Co., a division of Lockheed Aircraft Corp. The firm claims that the laboratory is one of the most complete facilities of its type in the solid-propellant industry.* . . . The Panelyte Industrial Division of Thiokol Chemical Corp. has opened a new sales-service office in Florida. Patrick P. Ryan will manage the office. . . . *Motorola, Inc., Chicago, plans new facilities to manufacture specially designed, highly stable crystal filter devices. The facilities, to be set up in Motorola's Filter and Crystal Research Laboratory, will enable production of a whole new line of filters to be marketed by the Measuring Instrument Dept. of the firm's Communications Div.* . . . Union Carbide Corp.'s Linde Co. has begun construction of what it says will be the nation's largest liquid hydrogen plant. The $20-million plant will be located on a 56-acre site near Sacramento, Calif. . . . *In a move to expand its technical liaison and business functions in the Los Angeles area, Grumman Aircraft Engineering Corp. will move these functions of its operations into enlarged quarters in the Los Angeles International Airport Aerospace Industry Complex at El Segundo. The move, scheduled for the middle of next month, will allow for a planned increase in personnel for these functions.* . . . Stencel Aero Engineering Co. has dedicated its new plant at Asheville, N. C. Stencel designs and manufactures parachute equipment for missile/space and other applications.

Martin Settles Union Disputes

"Extremely satisfactory" is the term used by officials of Martin Marietta Corp. and the United Auto Workers to describe recent settlement of labor disputes affecting missile bases in four states.

Negotiations leading to the settlement were conducted at Vandenberg AFB, Calif. (affecting 400 workers), and in Tucson, Ariz. (1200 missile workers).

UAW Vice President Leonard Woodcock praised the industry negotiators for bargaining that "was consistently forthright." He said he "found it refreshing to sit across the table" from Martin management.

According to Woodcock, the Vandenberg AFB settlement is worth more than 20 cents an hour this year, with added increases of at least 10 cents hourly during the final two years of the three-year agreement.

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contracts and procurements

AWARDS

AIR FORCE

$6,350,926—**Aerojet-General Corp.,** Sacramento, for production of *Titan* missile propulsion systems.

$6,141,536—**North American Aviation's Rocketdyne Div.,** Neosho, Mo., for rocket engines.

$4,546,500—**Avco Corp.,** Wilmington, Mass., for *Minuteman Mark V* re-entry system and re-entry technology.

$4,350,156—**IBM, Inc.,** New York City, for supplemental work on SAGE system maintenance and logistic support at all SAGE centers.

$4,060,630—**Revere Copper and Brass, Inc.,** Brooklyn, N. Y., for production of electronic countermeasures material.

$2,200,000—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for work on the operational subsystems and services for *Atlas* and *Titan* missiles.

$2,000,000—**Douglas Aircraft Co.,** Santa Monica, for Vandenberg Air Force Base launch services.

$1,700,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on space programs.

$1,254,736—**North American Aviation, Inc.,** Neosho, Mo., for *Thor* rocket propulsion systems.

$1,116,606—**Boeing Co.,** Seattle, for work on *Minuteman* sites.

$1,030,000—**Lear Siegler, Inc.,** Grand Rapids, Mich., for provision of advanced technology in flight vehicle control.

$1,000,000—**Martin Marietta Corp.,** Denver, for *Titan I* support engineering services.

$678,699—**Bridgeport Brass Co.,** Riverside, Calif., for *Sidewinder* missile metal motor parts.

ARMY

$11,031,919—**Western Electric Co.,** New York City, for *Nike-Hercules* modification kits. Work to be done at Burlington, N. C., and Springfield, Ohio.

$3,700,000—**Sperry Utah Co.,** Salt Lake City, for continued work on logistics support of the *Sergeant* weapon system.

$2,100,000—**Hayes International Corp.,** Birmingham, Ala., for production of *Pershing* missile trainers and providing engineering services for the trainers (2 contracts).

$1,350,000—**Raytheon Co.,** Andover, Mass., for production of *Hawk* missile radar repair parts.

$1,336,778—**Sperry Utah Co.,** Salt Lake City, for engineering services for the *Sergeant* missile system.

$1,300,000—**Radio Corp. of America's Defense Electronic Products Div.,** Burlington, Mass., for research and development on electronic missile system test equipment.

$423,987—**Sperry Utah Co.,** Salt Lake City, for *Sergeant* missile motor and guidance containers and launcher equipment.

$206,500—**Hughes Aircraft Co.,** Culver City, Calif., for modifications to the *Nike-Hercules* backward wave oscillators.

$132,065—**Randall Co.,** Los Angeles, for *Little John* missile fins and barrel assembly.

NAVY

$7,808,500—**Thiokol Chemical Corp.,** Bristol, Pa., for liquid propellant rocket engines.

$5,463,798—**General Electric Co.,** Pittsfield, Mass., for *Polaris* fire-control systems.

$5,200,000—**Westinghouse Electric Corp.,** Sunnyvale, Calif., for manufacture of *Polaris* launching systems.

$4,618,698—**Bendix Corp.,** North Hollywood, Calif., for sonar sets and components.

$4,500,000—**ITT Federal Laboratories,** Nutley, N. J., for provision of advanced air navigation equipment.

$4,500,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for *Subroc* guided missiles.

$2,591,498—**General Mills, Inc.,** Minneapolis, for work on *Asroc* antisubmarine missiles (2 contracts).

$2,489,880—**Watkins-Johnson Co.,** Palo Alto, Calif., for design, development, fabrication and testing of a traveling-wave-tube amplifier suitable for use in military communications satellite systems.

$1,486,000—**Jen Mar Construction Co.,** San Diego, for construction of a simulation and vectoring facility at the Point Mugu Navy missile center.

$1,481,582—**General Electric Co.,** Pittsfield, Mass., for guided missile fire control components.

$1,365,000—**Northrop Corp.'s Ventura, Calif., division,** for production of KD2R-5 radio-controlled target drones.

$1,100,000—**General Precision's Aerospace Group,** Pleasantville, N. Y., for production of Doppler radar navigation systems.

$983,432—**Vitro Corp. of America,** Silver Spring, Md., for engineering services on the *Tartar, Terrier, Talos* and *Typhon* weapon systems.

$200,000—**Sylvania Electric Products, Inc.,** Williamsville, N. Y., for investigation of the detailed structure of the ionosphere and its effect on communications systems.

NASA

$15,029,420—**Raytheon Co.'s Missile and Space Div.,** Sudbury, Mass, for an *Apollo* guidance computer subsystem.

$2,000,000—**Leach Corp.,** Compton, Calif., for lunar flight tape recorders.

$1,500,000—**Dalmo Victor Co.,** Belmont, Calif., for development and manufacture of satellite automatic tracking antenna systems (SATAN).

$1,300,000—**General Dynamics/Convair,** San Diego, for *Little Joe II* launch vehicles.

$509,252—**Computer Concepts, Inc.,** Washington, D. C., for *Centaur* programming support.

$179,216—**B. F. Goodrich Co.,** Akron, Ohio, for *Gemini* space suits.

$150,000—**Telemetrics, Inc.,** Gardena, Calif., for a pulse-code-modulation (PCM) decommutation systems.

$96,637—**American Bosch Arma Corp.,** Garden City, N. Y., for design study on solid state circuitry in the *Saturn V* propellant transfer control system.

Kaiser Engineers, Inc., Oakland, Calif., for design of a $25 million space propulsion facility at Sandusky, Ohio. (Undisclosed amount.)

INDUSTRY

$2,000,000—**Pacific Semiconductors, Inc.,** Lawndale, Calif., from **North American Aviation's Autonetics Div.,** for *Minuteman* silicon computer diodes.

$1,800,000—**Bendix Corp.'s Bendix-Pacific Div.,** North Hollywood, Calif., from **Lockheed Missiles and Space Co.,** for *Polaris* missile guidance components.

$350,000—**North American Aviation, Inc.,** Columbus, Ohio, from **Philco Corp.,** for fabrication of a 110-ft. diameter radome.

$330,000—**General Dynamics/Convair,** San Diego, from **North American Aviation's Autonetics Div.,** for production of guidance housing assemblies for the *Minuteman* missile.

Fairchild Camera and Instrument Corp., Syosset, N. Y., from **Jet Propulsion Labs,** for development of a space optical systems. (Undisclosed amount.)

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Operations Support Div.
Contract Services Branch
Norton Air Force Base, Calif.

Order 04-607-63-1 is being processed against Contract AF 04(607)-7569 for revisions, changes and supplements to tech manuals for the SM-65 (*Atlas*) propulsion systems. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with Rocketdyne Div., North American Aviation, Inc., 6533 Canoga Ave., Canoga Park, Calif.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with Battelle Memorial Institute, Columbus, Ohio, for the fabrication of beryllium impact targets. RFP C-76353. Note: For information purposes only. No RFP available.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Tex.

Universal testing machine. Requests for proposals will be entertained from firms capable of engineering, design, fabrication and installation of a 100,000 lb. universal testing machine. Item—RFP-MSC-63-445P. RFP due date 5-28-63.

Bureau of Naval Weapons
Washington 25, D. C.

The Bureau of Naval Weapons contemplates award of a contract to Lockheed Aircraft Corp., Sunnyvale, Calif., to furnish four sets of A3P motors for *Polaris* missiles. This requirement can only be obtained from the above firm which is currently developing the *A3* missile. This notice is made for information purposes only. P. R. No. SP 1200-63. BuWeps Synopsis No. 346-63.

Hercules Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

The U. S. Army Missile Command proposes to procure through the Philadelphia Procurement Dist., U. S. Army, five each *Hercules* AN/MP Q-T1 simulator stations and 13 each AN/MPM-55 test ships from Aircraft Armaments, Inc., Cockeysville, Md. All inquiries concerning subcontracting opportunities in connection with the above procurement must be addressed to Aircraft Armaments, Inc., Cockeysville, Md.

The U. S. Army Missile Command proposes to place requirements upon the Philadelphia Procurement Dist., U. S. Army, for contract with Aircraft Armaments, Inc., for the furnishing of repair parts for the *Hercules* AN/MPQ-T1 simulator trainer and test ship AN/MPM-55. All inquiries concerning subcontracting opportunities in connection with order placed against the basic ordering contract must address Aircraft Armaments, Inc., Cockeysville, Md.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Negotiations will be conducted with Electronic Associates, Inc., Long Branch, N. J., for additional diode function generators compatible with existing computing equipment. RFP A-6826. Note: For information only. No RFP available.

Vacuum valve, gate type, 48 in. size, pneumatic cylinder operated—2 each. IFB A-6834. Bid opening 3-25-63. Copies of IFB or RFP will be furnished to the extent available on a first-received, first-served basis.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with General Electric Co., Schenectady, N. Y., to conduct a research program for the development of high-temperature ceramic rectifiers, thyratrons and voltage regulator tubes for long-term use in nuclear electric space power systems. Note: For information only. No RFP available.

Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.
Attn.: J. M. Hollis

Development and fabrication of a waste-management system for use on medium time duration space vehicle utilizing an incineration method. Job—RFP MSC-63-380P. RFP due date 4-5-63.

Warner Robins Air Materiel Area
Robins Air Force Base, Ga.
Attn.: Procurement & Production

Following items are procured under RFP 09-603-63-3183Q. RFP due date 3-29-63. Replacement parts in support of *IM-99, SM-68* and *SM-65* missiles consisting of: filter element, W/O filter, fluid pressure, Air Dry Corp., PN NR1500, FSC 4330-083-5297—142 each; filter fluid, pressure: permanent type, W/O cleaning blade, Minneapolis Honeywell PN, 230A015, FSC 4330-7836721—14 each; non-re-usable element, W/O cleaning blade, inside-out flow, Cuno Engineering PN 2278B3, FSC 4330-796-4452, 35314—4 each. Destinations to be furnished. Complete data not available. Notice is given that specs, plans or drawings relating to the procurement above are not available and cannot be furnished by the government.

GUIDANCE AND CONTROL

(Manned Spacecraft, Research, Advanced Systems)

North American Aviation's Space and Information Systems Division has several assignments of exceptional scope and interest available to qualified engineers and scientists.

Tasks in the Guidance and Control Department range from actual hardware evaluation to theoretical postulation of advanced systems.

PERFORMANCE

ASTRODYNAMICS: Orbit prediction and determination. Stability analysis and effects of model uncertainties. ORBITAL MECHANICS: Atmospheric and Space trajectory analyses. Development of design and operational criteria. Reference trajectory generation.

GUIDANCE & NAVIGATION

Guidance equation mechanization for rendezvous and lunar landing • Orbit determination and correction, earth entry, and boost • Airborne guidance and control digital computer requirements and programming • Inertial guidance • Radar guidance (DSIF, Lunar landing doppler and altimeter, rendezvous radar, and recovery system) • Statistical error analysis techniques • Martian and interplanetary navigation.

STABILIZATION & CONTROL

Servomechanisms analysis • Advanced dynamics • Analog and digital computer simulation • Linear and non-linear systems analysis • Systems design analysis and mechanization • Sun seekers, horizon scanners, rate inertial gyros • Thrust vector control studies.

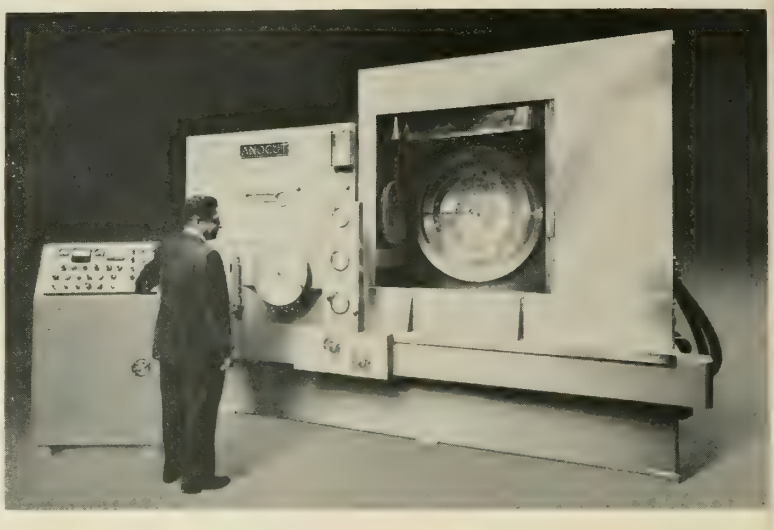
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SPACE & INFORMATION SYSTEMS DIVISION
North American Aviation

products and processes



New Product of the Week: Electrochemical Machining Unit

ANOCUT ENGINEERING CO. has developed the first piece of its "second-generation" electrochemical machining equipment.

It is designed for use with a Model 10,000 (ampere) Anocut Power Supply Unit. The machine is basically a horizontal unit and has been dubbed the "wagon wheel" machine because of the 42-in.-dia. stainless steel rotary index table mounted inside the enclosure. The table is positioned by an air-operated shot-pin, controlled at the operator's console.

Deflection of the ram at full extension is less than 0.0002-in., with a transverse load force of 1000 lbs. The drive-head assembly, with crossslide, weighs over 4000 lbs.

The negative d-c current for electrolytic machining and the electrolyte fluid are brought into the stainless-steel enclosure through the hollow interior of the ram, thereby freeing the work zone of cables and hoses.

Circle No. 225 on Subscriber Service Card

Calibration System

A vacuum gauge calibration system, accurate to ±6% at pressures down to 5×10^{-7} Torr, is available from Vacuum Products Division of Varian Associates.

The Model 964-0008 precision calibration within ±4% from 10^{-3} down to 2×10^{-6} Torr, and ±6% from 2×10^{-6} down to 5×10^{-7} Torr.

The calibration system utilizes a 125 liter/sec. VacIon® pump which can be valved off before the system is open to air. This feature greatly improves cycling speed and reduces the pump starting time. Either a sorption or a mechanical roughing system can be used to reduce pressure from atmosphere to 10^{-3} Torr; below this pressure the VacIon Pump takes over.

The system operates within a temperature range of 15° to 35°C and a humidity range of 0 to 95%. Set-up time is approximately 1½ hours for eight gauges; conditioning or stabilization time is eight hours; and measurement time is approximately 20 min. for each point of calibrated pressure.

Circle No. 226 on Subscriber Service Card

Amp Diode

The Standard Rectifier Division of American Micro Devices, Inc., has available a 450-amp diode which is capable of repeated 12,000-amp surges for 4 milliseconds, and can handle a repeated 75% overload for 45 sec.

Capable of 2250 amps d-c in three-phase YY continuous operation, the diode handles peak inverse voltages of 800 volts. The 450-amp diode also reduces the number of paralleling reactors needed and saves on size and weight.

Circle No. 227 on Subscriber Service Card

Titanium Fasteners

Standard Pressed Steel Co. has developed a family of titanium bolts usable to 750°F. The SPS- Hi-Ti 815 series is

available in both tension and shear bolts. These meet NAS 621 fatigue requirements, and are rated at an ultimate tensile strength of 145,000 psi minimum and an ultimate double shear strength of 90,000 psi minimum.

A tensile strength of approximately 125,000 psi is available at 750°F. Furthermore, no appreciable change in properties is indicated by these tests conducted at room temperature after exposure to 750°F.

Circle No. 228 on Subscriber Service Card

Cermolox Beam Power Tube

A forced-air cooled UHF beam power tube is being marketed by the RCA Electron Tube Division for use in pulsed RF amplifier service in compact aircraft, mobile and stationary equipment.

The RCA-8184 is rated for a maximum peak power input of 2 megawatts as a plate-pulsed RF amplifier at the following conditions: for a maximum "on" time of 10 microseconds in any 2000-microsecond interval, and for frequencies up to 500 Mc.

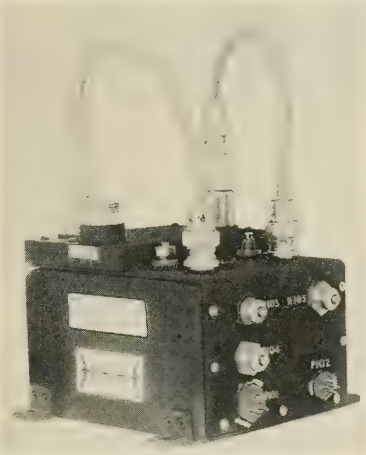
Design of the beam power tube features cermolox construction which includes precision-aligned grids, ceramic metal structure, and unitized cylindrical-electrode-and-terminal design. The precision alignment of the grids minimizes grid and screen currents and permits high-efficiency operation with relatively low plate voltage to give large power output with small driving power.

Circle No. 229 on Subscriber Service Card

Single-Sideband Modulator

A highly versatile, selectable C-band single-sideband modulator, also called a frequency translator, is being marketed by Micro-Radionics, Inc.

The unit may be used in production



test equipment and in applications where sidestepping of frequency is required, as well as in all standard single-sideband modulator requirements.

The Model C993-700—001, modulates the RF signal by a 70-mc crystal controlled oscillator producing the upper or lower sidebands at the output. The input signal frequency can also be obtained at the output. Versatility is indicated by the built-in relays which can be remotely operated to select one of the three desired frequencies. With the RF input power between —10 and 30 dbm, conversion loss of 7 db and sideband suppressions of greater than 25 db have been obtained, and the amplitudes of the three outputs are within ±0.5 db. The oscillators and relays operate at —28v d-c.

Circle No. 230 on Subscriber Service Card

Molding-Mat

Johns-Manville has developed an asbestos-phenolic molding mat in felt form, J-M, Thermomat Style 383, which provides exceptionally lightweight thermal shielding, and high strength-to-weight ratio.

The J-M Thermomat Style 383 is composed of an unbonded felt containing 100% ASTMA grade AAAA long, randomly dispersed chrysotile asbestos fiber and lightweight fillers saturated with a phenolic resin conforming to military specification MIL-R-9299.

Circle No. 231 on Subscriber Service Card

TO MEN WHO CAN LOOK DEEP INTO TOMORROW

Top echelon positions are open to men with vision at Bell Aerosystems Co. This growing organization today needs *more* senior scientists and engineers who can perceive where technology should go to meet tomorrow's aerospace requirements — and lead the way to advances beyond the existing state-of-the-art.

Vision coupled with sound engineering judgment has always been characteristic of this Company, as exemplified by such achievements as:

- The AGENA Rocket Engine, workhorse of the space age, proven most reliable on a variety of satellite and space probe launches for the USAF and NASA
- Reaction controls for Mercury and other space vehicles
- The FIRST Rocket Belt for man in free flight

SENIOR POSITIONS ARE NOW OPEN IN:

ROCKET DEVELOPMENT

To conduct analytical and design studies and investigations in all areas of liquid propellant engines and systems; perform conceptual design and supporting analyses for new rocket propulsion devices.

ROCKET SYSTEMS

Analysis for propulsion systems of interrelated effects of system configuration changes, cumulative controlled tolerances of components, thermal variations, hardware interchangeability and dynamic conditions on gas storage requirements, and system steady state and transient performance.

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MATERIALS RESEARCH

Engineers with thorough background in any of the areas listed are invited to inquire about these high level opportunities. Please address Mr. T. C. Fritschi, Dept. C15.

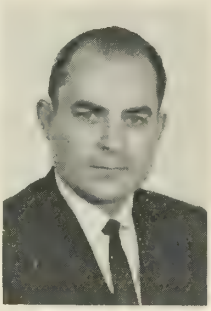
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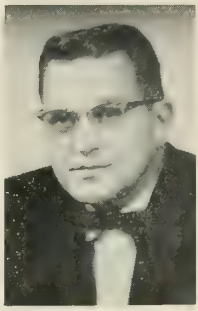
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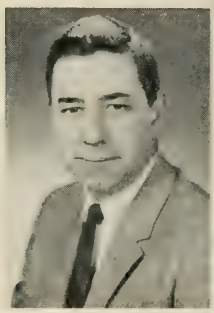
Hefner



Levon



Smith



Cooley

Charles M. Mooney: Appointed division vice president, government marketing, for RCA's Electronic Data Processing operations, with offices in Washington, D.C.

Lawrence P. Mordaunt: Appointed director of marketing for the Avionics Div. of Textron's Bell Aerosystems Co., Buffalo, N.Y.

Karl E. Friese: Appointed assistant to the president of IMC Magnetics Corp., Westbury, N.Y.

Howard W. Hefner: Appointed manager of fabrication at Weinschel Engineering, Gaithersburg, Md.

P. L. Smith: Named manager of market analysis and assistant to the director of marketing at Douglas Aircraft Co.'s Missile & Space System Div., Santa Monica, Calif. **F. F. Duquette** appointed manager of the field operations branch. **G. D. Morse** named manager of market development, and **J. W. Shaver** named manager of international sales.

Robert W. Kellhofer: Named western region vice president of North American Aviation's Autonetics Div., Anaheim, Calif.

Dewey Clower: Named sales manager of the Washington, D.C. regional sales office of Radiation at Stanford's RF Systems Div.

Bruce H. Stafford: Appointed chief of Operations Analysis at Strategic Air Command headquarters, Offutt AFB, Neb.

William E. Fogarty: Appointed director of operations of the Reaction Motors Div. of Thiokol Chemical Corp., Denville, N.J. **Elmore M. Peloubet** appointed program manager of components. **John A. Black** appointed manager of the Manufacturing Engineering Dept., and **Charles J. Koeder** named manager of the Manufacturing Dept.

John J. Graham and Ted B. Westfall: Elected to the board of directors of International Telephone and Telegraph Corp., New York City.

F. Gordon Smith: Appointed vice president, European Marketing, at Sperry Rand Corp.'s UNIVAC Div., New York City.

John S. Liefeld: Appointed vice president of operations for the Astro Structures Div. of Lear Siegler, Inc., El Segundo, Calif.

Joseph M. Levon: Appointed project engineer for Waterman Hydraulics Corp., Evanston, Ill.

Kirke K. Wyatt: Named general sales manager of the Pump, Hydraulic and Electrical Div. of Fairbanks, Morse & Co., Kansas City, Kan.

Einar M. Ramberg: Named chief of engineering services at United Aircraft Corp's Hamilton Standard Div., Windsor Locks, Conn. **Paul H. Tetrault** named plant engineer.

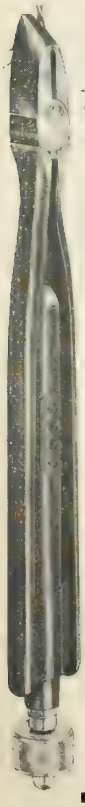
Wendell F. Smith: Appointed marketing manager of ARACON Laboratories division of Allied Research Associates, Inc., Concord, Mass.

G. Jackson Butterbaugh: Named director of public relations for Textron's Bell Aerosystems Co., Buffalo, N.Y.

B. I. Maynard: Appointed director of operations control for the Douglas Aircraft Co.'s Missile & Space Systems Div., Santa Monica, Calif.

Stanley D. Haffey: Named general manager of operations at Avco Corp.'s Electronics Div., Cincinnati.

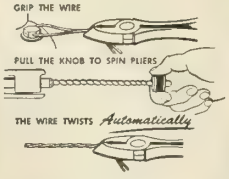
Henry E. Cooley: Promoted to director of project assurance in the IBM Federal Systems Div., Rockville, Md.



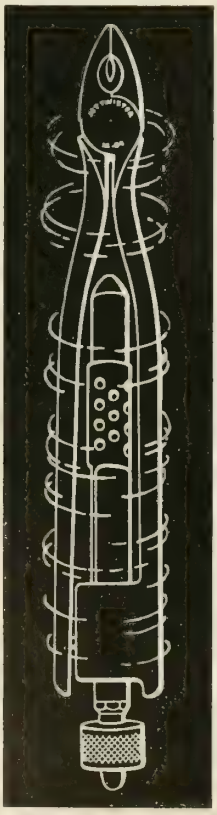
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American Society for Metals, Western Metal Exposition and Congress, Pan Pacific Auditorium, Los Angeles, March 18-22.

Society for Nondestructive Testing, Spring National Convention, Ambassador Hotel, Los Angeles, March 18-22.

Second Air Force Symposium on Bionics, Biltmore Hotel, Dayton, Ohio, March 19-21.

Optical Society of America, Spring Meeting, Robert Meyer Hotel, Jacksonville, Fla., March 25-27.

American Physical Society Meeting, St. Louis, March 25-28.

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An Appeal to the President

WE ARE IN a strategic space race with the Russians and we have been losing. The first man-made satellite to orbit the Earth was named *Sputnik*. The first living creature in space was Laika. The first rocket to the Moon carried a Red flag. The first photograph of the far side of the Moon was made with a Soviet camera. . . .

Control of space will be decided in the next decade. If the Soviets control space they can control Earth, as in past centuries the nation that controlled the seas dominated the continents. This does not mean that the United States desires more rights in space than any other nation. But we cannot run second in this vital race. To insure peace and freedom, we must be first.

The target dates for a manned space platform, U.S. citizen on the Moon, nuclear power for space exploration, and a true manned spaceship should be elastic. All these things and more we should accomplish as swiftly as possible. This is the new age of exploration; space is our great New Frontier.

THE WORDS ABOVE were not written by the editor of MISSILES AND ROCKETS. They were written by President of the United States John F. Kennedy. They appeared in an article he wrote for the Oct. 10, 1960 issue of M/R—less than a month before his election.

We appeal to the President to carefully consider once again what he said at that time:

"If the Soviets control space, they can control Earth. . . ."

Mr. Kennedy's article was written in response to a nine-point proposal by this magazine for an effective national defense and space policy. These points included recognition that "space for peaceful purposes" is possible only if "freedom of space" is ensured by giving the U.S. military a predominant role in developing and carrying out the projects necessary to guarantee freedom of space.

This is what Mr. Kennedy said in his response:

"The space and defense proposals of MISSILES AND ROCKETS parallel, although in somewhat more detail, those of the Democratic Party platform. They are in line with my own thinking; our goals are identical."

WE MUST ASK, Mr. President, what has happened to your thinking? Why are our goals, in a little more than two years, now so far apart?

In agreeing to our proposal for an effective U.S. military space program, you called it "an umbrella under which we can explore and develop space for the benefit of all mankind."

There is no such umbrella, Mr. President, and the events of the past two months have made it exceedingly clear that there is no prospect of one.

The course upon which you are embarked is endangering the future security of the United States as no other President has done. We do not make this charge lightly. There are serious reasons for making it at this time.

Foremost is the fact that the Russians themselves have taken your words of October, 1960, at their face value. Marshal Vasiliy Danilovich Sokolovskiy, First Deputy Minister of the Soviet Armed Forces, recently has published what an Air Force official calls the first comprehensive treatment of Soviet doctrine and strategy since 1926, a book entitled *Military Strategy*.

In that book, Marshal Sokolovskiy cites your statement of October, 1960, in MISSILES AND ROCKETS that the country which controls space can control the Earth. He says the Soviet Union "cannot disregard" what he calls U.S. plans to use space exploration for military purposes.

Sokolovskiy states that the Soviet Union cannot allow the U.S. to become superior in this field "in any way." He says the Soviet Union must oppose the U.S. with "more effective means and methods by the use of space for defensive purposes."

The implication is plain that the Soviet Union is embarked on a military space program.

What, meanwhile, is the status of the U.S. military space program which the Russians are using as an excuse for embarking on military space projects of their own?

- The exclusive reports in this magazine that the *Dyna-Soar (X-20)* project was to be given the axe now have been confirmed. No less an authority than your Secretary of Defense made that clear in his statement to Congress on *Dyna-Soar*: "It will cost to complete, in total, including funds spent to date, something in the order of $800 million to $1 billion. The question is, do we meet a rather ill-defined military requirement by proceeding down that track, or do we meet it better by modifying *Gemini* in some joint project with NASA? . . . I think we can cut back very substantially while better meeting both of our requirements, and that is our objective."
- The *Rover* program for development of a nuclear rocket for space, which you said in October, 1960, should be accomplished as swiftly as possible, has slipped 14 to 16 months behind schedule.
- The *MIDAS* program, for development of an early-warning satellite system, has been cut back to a study effort.
- *SAINT*, the program to develop a capability for inspecting possibly hostile satellites, has been cut back in favor of a more distant goal.
- *Blue Gemini*, the Air Force program for developing its own space flight capabilities, has been abandoned in favor of the joint project with NASA.

Where, Mr. President, is the effective and predominant military space program which you agreed is so vital to our national security? It does not exist—and current developments are pushing any prospect of its implementation into the far distant future.

We charge you with neglect of our national security in your own words, Mr. President: "If the Soviet control space, they can control Earth."

William J. Coughlin

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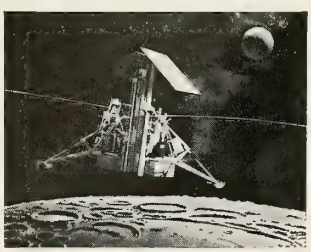
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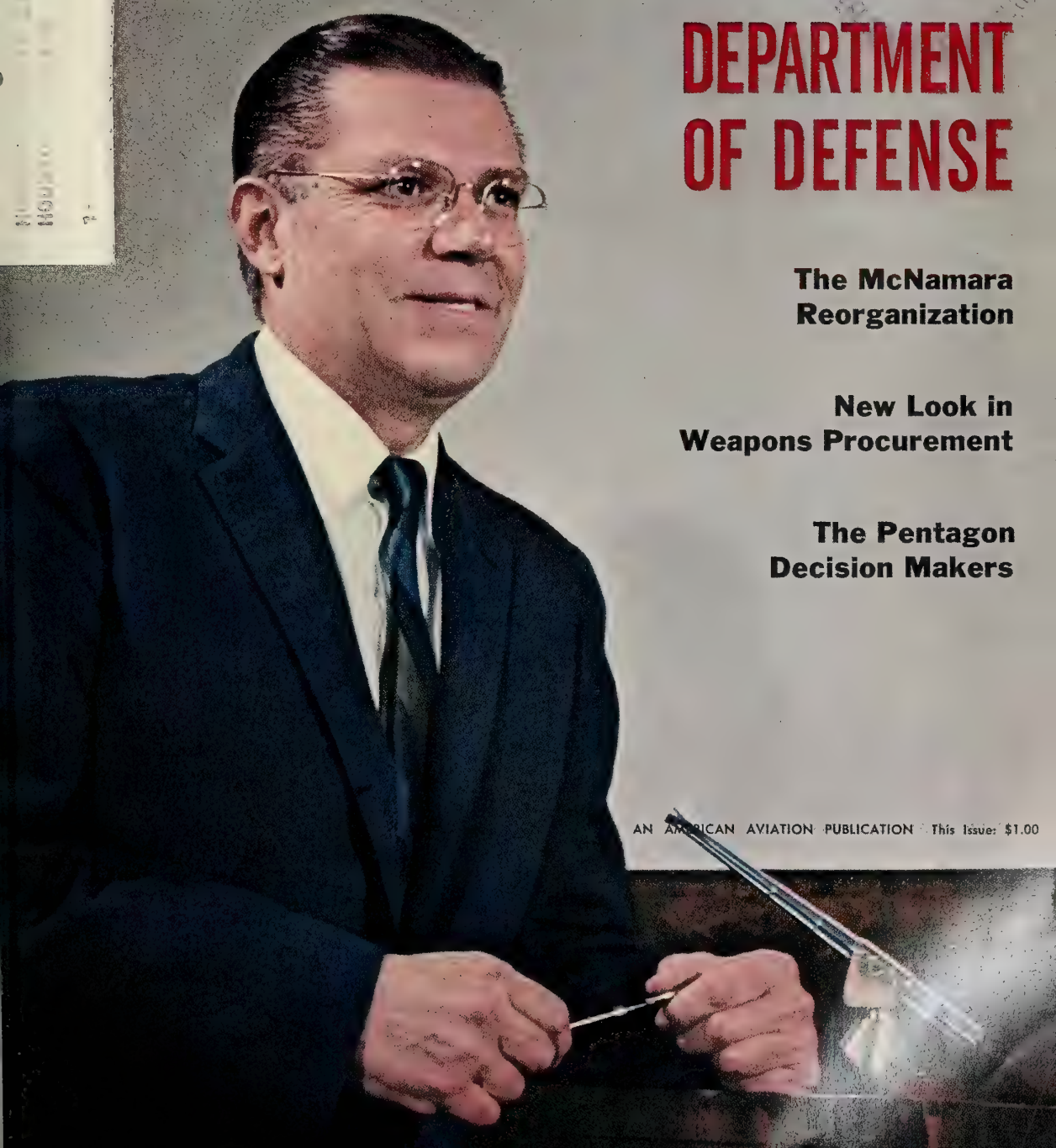
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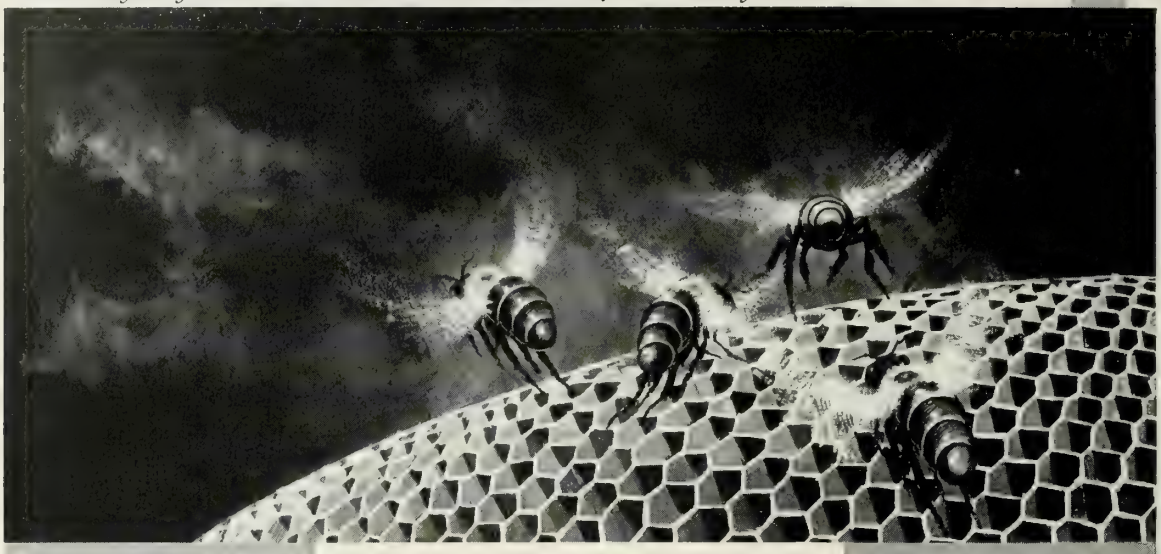
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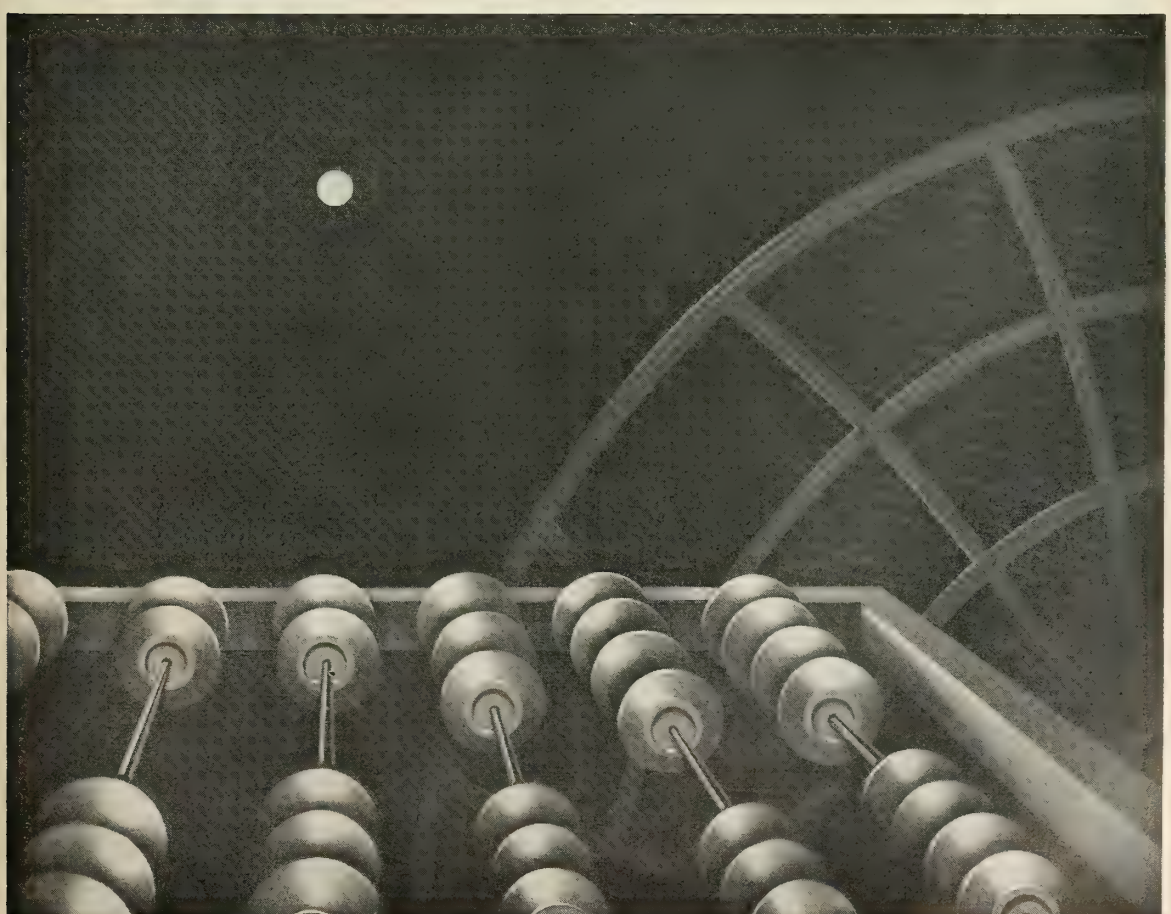
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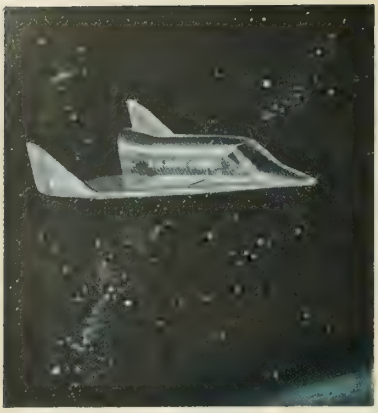


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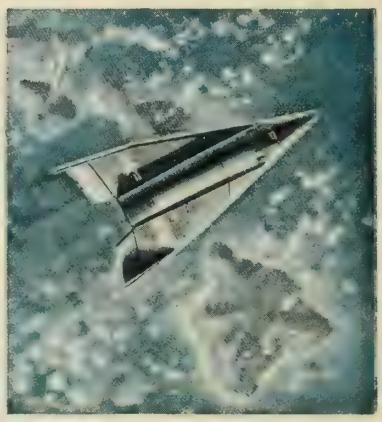
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missiles and rockets

Volume 12, Number 12 March 25, 1963

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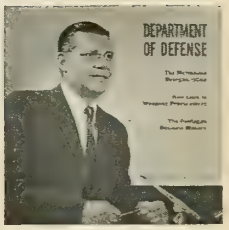
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THE COVER

Secretary Robert S. McNamara's drastic reshaping of Defense Dept. policies and operations, and its effect on industry, are the subject of this special Military Systems Issue of MISSILES AND ROCKETS. *(Photo by Vince Finnigan.)*



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memo from the publisher

A WEEK AGO SATURDAY, the day before St. Patrick's day, three Irishmen tossed questions and answers across a desk in the E Ring of a nearly deserted Pentagon.

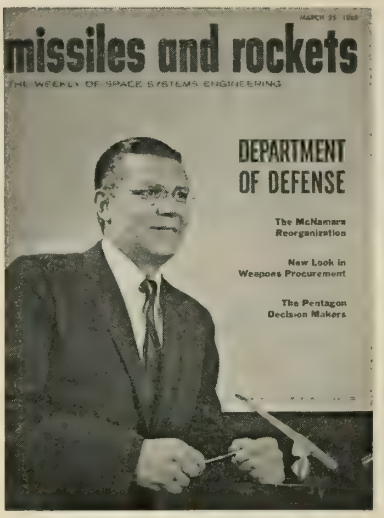
Behind the desk was Secretary of Defense Robert S. McNamara, just back from a tour of *Dyna-Soar* and *Gemini* facilities in Houston and Seattle. His interrogators were MISSILES AND ROCKETS Editor William J. Coughlin and Associate Editor Frank McGuire, putting the capstone on an intensive eight-week investigation of DOD operations by the M/R staff.

No organization in this country spends so much money or makes such far-reaching decisions as the Department of Defense. It is an extremely complex, ever-changing, vital assembly of civilian administrators, military services, and accessory agencies—having power of virtual life or death over most of the missile/space industry.

Since its assumption of DOD leadership, the McNamara team in the Pentagon has been something of a mystery to the industry. The department has drawn a mixture of considerable fire and praise for its decisions and management techniques. Few publications have ever spelled out just why these decisions are made, what the management techniques are, or what philosophies and policies lie behind the entire Pentagon operation.

In this issue, MISSILES AND ROCKETS presents the answers to questions our editorial staff has been asking of top Defense Department officials for weeks. These are the answers the missile/space industry *must* know if it is to conduct its business successfully; design its programs successfully; and plan for the future successfully.

New military systems concepts now are originating in the Pentagon and flowing out to industry to a greater degree than ever before. What does this mean for the missile/space industry? It means that a keener ear must be tuned to what DOD is seeking—in engineering designs, in cost estimates, in overall planning and in contractor performance. It also means a sharper eye must be kept on the contract dollar and on subtle changes as to where DOD plans to spend this dollar. As our editors found in several dozen interviews: the key to successful defense contracting nowadays is planning, planning, planning.



During previous years, the most common complaint heard from industry concerned lack of direction in the missile/space programs. "Any decision is better than no decision at all," became the watchword. Now the McNamara team is making decisions and making them firmly. The thinking and the policy behind these decisions—as well as the organizations doing the thinking—are carefully examined in this special issue. Balanced against DOD's view of its own operations—as depicted in the interviews—we have reported industry, military and Congressional criticism of that operation.

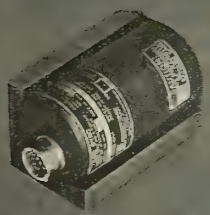
THIS ISSUE also marks the end of the first quarter of our publishing year. I am pleased to report that circulation continues to grow at a rapid rate, with over 6,000 new subscribers since this same date last year. Also, as we end the first quarter, our advertising lineage is up by 99 pages over the same period last year. This on the heels of a 113-page gain in 1962.

Many of you will be pleased to see Hal Gettings' byline back in MISSILES AND ROCKETS. Hal was an M/R staffer from 1959 to 1961, when he left us for a public relations job in industry. His new assignment with the magazine will be on the West Coast, covering the electronics industry.

JAMES W. CLAAR
OFFICE OF THE PUBLISHER

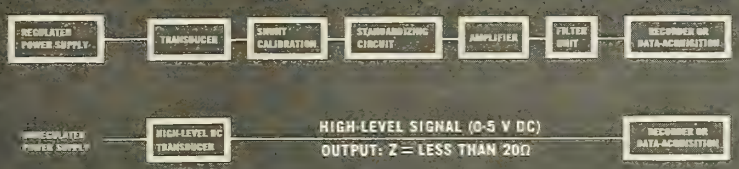
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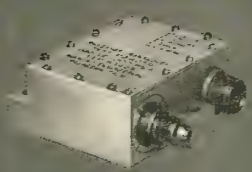
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Tamar: three typical contributions to electronics

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letters

Politics and Procurement

To the Editor:

I read with considerable interest your editorial, "Politics and Procurement" (M/R, March 4, p. 58).

In view of your searching analysis of this particular part of the problem, I look forward to your future editorial examining what I believe is the even more serious aspect of "politics and procurement," namely that influence warned of by President Eisenhower in his farewell address, probably the most politically significant speech of his career.

You will, I'm sure, recall this portion of that speech:

"Our military organization today bears little relation to that known by any of my predecessors in peacetime, or indeed by the fighting men of World War II or Korea.

"Until the latest of our world conflicts, the United States had no armaments industry. American makers of plowshares could, with time and as required, make swords as well. But now we can no longer risk emergency improvision of national defense; we have been compelled to create a permanent armaments industry of vast proportions.

"Added to this, 3½ million men and women are directly engaged in the defense establishment. We annually spend on military security more than the net income of all U.S. corporations.

"This conjunction of an immense military establishment and a large arms industry is new in the American experience. The total influence—economic, political, even spiritual—is felt in every city, every statehouse, every office of the Federal Government.

"We recognize the imperative need for this development. Yet we must not fail to comprehend its grave implications. Our toil, resources and livelihood are all involved; so is the very structure of our society.

"In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.

"We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted. Only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together."

"Politics of procurement" as practiced within the military-industrial complex, you will agree, poses a serious threat to our democratic society.

You will, I'm sure, in your future editorial also put under your powerful scrutiny the curious defense industry practice of appointing retiring military officers to highly-paid company positions as a reward for their influence in steering contracts through Defense Dept. channels to "their" companies. You might underscore the corrosive nature of this type of "politics" in defense procurement to our democratic institutions because it is the way the military-industrial complex recruits and perpetuates its own "Establishment" and maintains and extends its power.

It might help your editorial if you tabulated for your readers a list of those retiring military officers who obtained important corporate positions, their recent billets, what companies hired them, their civilian salaries, government retirement pay benefits, and other pertinent data such as recent contracts awarded to their companies.

I certainly look forward to the publication of this editorial because I'm certain it will put the "politics and procurement" problem in perspective.

Joseph E. Karth
House of Representatives
Congress of the United States
Washington

We refer Representative Karth to our Feb. 18 editorial, "Conflict of Interest." —Ed.

Conflict of Interest

To the Editor:

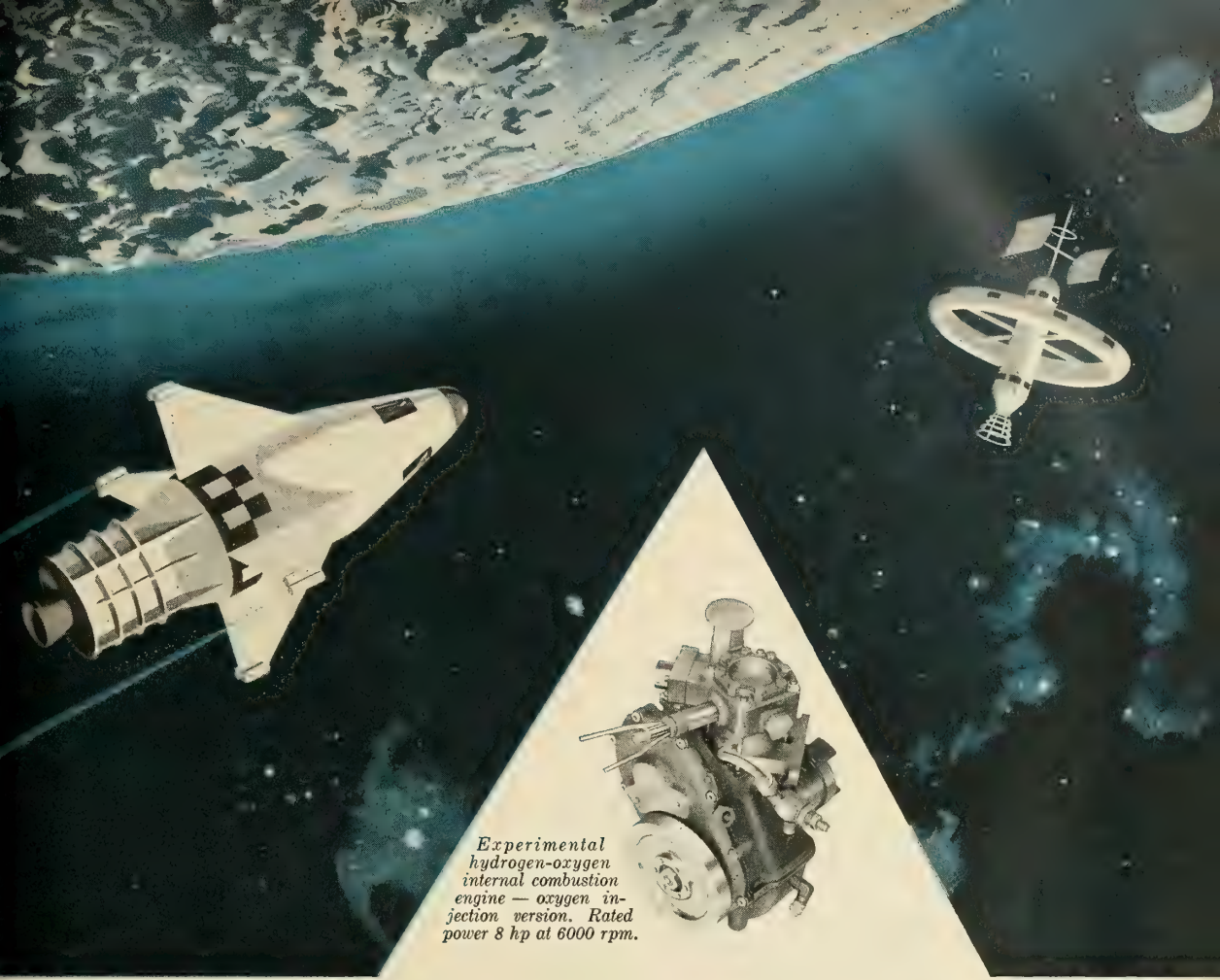
Your Feb. 18 editorial ("Conflict of Interest") in itself presents some conflicting viewpoints. On the one hand you question the need for, and value to industry, of 1400 retired field grade officers employed by the top 100 defense corporations. On the other hand you state that a truly capable military officer should not be denied the opportunity to work for industry (this statement being made without reservation). I would appreciate being enlightened on the number of officers you feel industry really needs—50, 100, 1000?

My purpose in raising the question is that as a field grade officer it may help me chart future Air Force careers. Despite having withstood the intense competition existing in today's military services, having progressed up the promotion ladder, and working at least a 25% longer day than my civil service subordinates, today I find that many of my civil service subordinates are drawing up to $5,000 a year more than I am. I have felt that upon retirement (20 years), having acquired much valuable R&D experience in AFSC I would be welcomed by industry. While enduring the sacrifices of military life I consoled myself with the thought that in industry, at least, a person would be compensated for his abilities and that subordinates would not be drawing appreciably higher pay than the boss. Now I am shocked to find that industry is overstaffed with retired officers and that this may be a blind alley.

It appears the time has come for our service people to face reality. Uncle Sam financially discriminates against the serviceman (incidentally, we too have fami-

(Continued on page 10)

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Experimental hydrogen-oxygen internal combustion engine — oxygen injection version. Rated power 8 hp at 6000 rpm.

CAPABILITY MEANS POWER FOR SPACE AND LANDING VEHICLES

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LIGHT WEIGHT—Low specific propellant consumption (0.75 to 1.0 lbs. per hp-hr.) in conjunction with low system fixed weight is offered by internal combustion engines currently being developed—a lighter system than any other for certain space missions.

BROAD CHOICE OF FUELS—A variety of fuels—cryogenics (liquid, supercritical fluids and boil-off vapor) or hypergolics—can be used.

TEST DATA AVAILABLE—For technical information and comparison of H_2-O_2 engine with other proposed systems ask for Technical Report—"Piston Engines For Space Power". Write to Vickers Incorporated, P. O. Box 302, Troy, Michigan.

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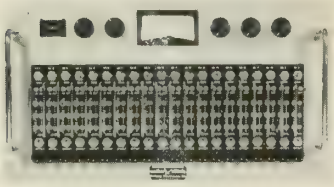
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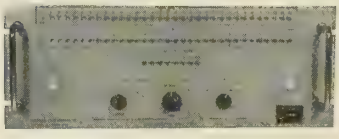


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Input Impedance	Greater than 500,000 ohms per subcarrier channel
Linearity	Less than ± 0.2% of bandwidth
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PTS-2 PCM SIMULATOR

A laboratory test instrument or field check-out aid in PCM telemetry systems, the PTS-2 will generate a variety of PCM codes and formats. The simulator generates a periodic frame synchronization word followed by a preset number of identical data words in a continuous serial pulse train, with each bit controlled by a front panel switch.

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. . . letters

(Continued from page 8)

lies), industry has no place for us when we retire, and we are still too young to lie down and die.

Name Withheld
(for obvious reasons)
Ohio

Dyna-Soar Demise

To the Editor:

Our part in the *Dyna-Soar* is minute, but as a citizen and a taxpayer and a potential target for Russky spacecraft, I heartily enjoyed and endorse your "Eulogy to a Dyna-Soar" editorial (M/R, March 11, p. 50). I'm getting scared of the way they're planning to protect me and mine from space attacks.

Art Schoeni
Ling-Temco-Vought, Inc.
Dallas

To the Editor:

In the past, when it has been in the national interest to cancel unneeded missile programs (as in the *Skybolt* affair), M/R has editorially supported such cancellations, even though some missile industries have been temporarily hurt. I am surprised, therefore, by M/R's continuous, all-out support for the unneeded, outdated *Dyna-Soar* (X-20) program. *Dyna-Soar* can support one man for a maximum of six orbits; *Gemini* can support two men for two weeks, and *Apollo* can support three men for still longer periods. *Gemini* and *Apollo* can perform rendezvous experiments; *Dyna-Soar* cannot. *Gemini* has as much maneuverability in re-entry and landing as is needed in practice; *Dyna-Soar's* additional capabilities in this regard are somewhat superfluous. Furthermore, *Gemini* and *Apollo* will be ready next year; *Dyna-Soar* will not make its first flight until 1966 at the earliest.

What, then, are the arguments in favor of *Dyna-Soar*? It does not represent an important step toward an aerospace plane, since the requirements for such a plane will be quite different, and will involve recoverable boosters. The only real argument for the *X-20* is that it gives the military a foothold in space, a policy contrary to the letter and spirit of the National Space Act. Continuance of *Dyna-Soar* also justifies the continued development of *Titan III*, an expensive and redundant booster whose missions, other than *Dyna-Soar*, include no projects that cannot be accomplished with existing rockets or the forthcoming *Saturn* series.

M/R would be more consistent if it advocated that outer space be preserved for peaceful purposes (as Antarctica is now) instead of a military race, and if it editorially pressed for a complete cancellation of *Dyna-Soar* and *Titan III* and a transfer of funds from these programs to *Gemini* and *Apollo*, in order to keep these vital NASA programs from slipping any further.

Jay D. Strieb
Philadelphia

47 New Career Positions at RAC

The Research Analysis Corporation [CAN YOU FILL ONE?] is expanding dynamically to meet greater and more complex responsibilities in scientific problem-solving. Headquartered in the Washington, D. C. area, with field offices in Europe and Southeast Asia, RAC applies the most advanced techniques of operations research and systems analysis to problems underlying many areas of major national decision —military, political, and economic.

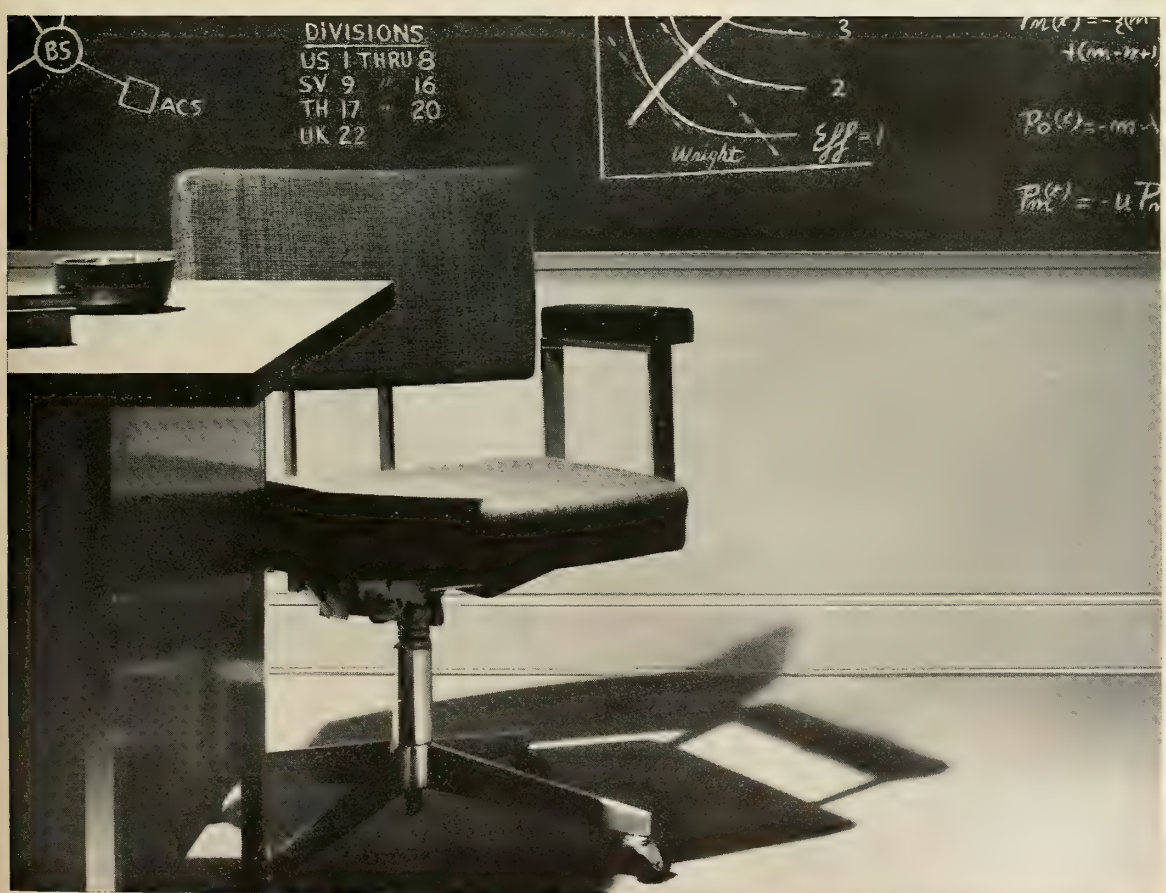
All of the 47 positions presently available require advanced degrees, and they span the entire 10-division complex of RAC. The majority call for mathematicians, mathematical statisticians, physical scientists, and engineers, with appointments available also to economists, chemists, meteorologists, and operations analysts.

You will work in an environment of creativity and accomplishment; easy interchange of ideas is aided in every way. A career appointment at RAC offers you the stimulation of practicing your own specialty alongside scientists and engineers of other disciplines (all told, there are 32 separate disciplines and technical specialties represented on RAC's professional staff). The interplay and synthesis of sciences that is such an important characteristic of operations research enables each participant to rise above his own field and adds an extra dimension to his efforts.

The assignments are often of immediate and major importance to the national purpose. Your growth opportunities and rewards will be in keeping with this level of activity. Please send your resume to Mr. John G. Burke, Professional Staffing, Research Analysis Corporation, 6935 Arlington Road, Bethesda 14, Maryland (residential suburb of Washington, D. C.). RAC is an equal opportunity employer.

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The Countdown

WASHINGTON

House To Probe Gemini Program

NASA's slipping *Gemini* program will come under close scrutiny by the House Space Committee when it calls D. Brainerd Holmes, manned spaceflight boss, for further testimony early next month. This follows a recent shakeup in project management at Houston's Manned Spacecraft Center. James A. Chamberlin, former project director, was moved upstairs to a position as senior engineering advisor to MSC director Robert Gilruth. Charles W. Mathews has been named acting *Gemini* director.

Bigger Minuteman Force Under Study

Total *Minuteman* buy may go eventually as high as 1300 missiles. Top Defense Dept. sources are talking about this figure. *Minuteman* now is being assigned the former *Skybolt* task of opening a penetration path for the B-52 bomber force.

Oh, To Be in May Now That April's Here

With only the *S-66 Polar Ionosphere Beacon* satellite scheduled for launch, April will be one of NASA's lightest launch months. *S-66* will go from Pacific Missile Range. Due to go this week from Cape Canaveral are *Saturn SA-4* and the *S-6* satellite.

Typhon Slippage Causes Ship Cancellation

Slippage in development of the *Typhon* air defense system for Navy ships has caused building of three guided missile ships planned in the Fiscal '63 and '64 budgets to be postponed. With the program again proceeding satisfactorily, a *Typhon* system will be installed aboard the Norton Sound test vessel for full-scale firings. Development of a smaller system, using less bulky radar, is being pushed to determine whether the system can be installed on ships lighter than a cruiser.

Space Agency Studies Lasers for Manned Craft

NASA's Manned Spacecraft Center is giving serious study to use of lasers in its manned spaceflight missions. A contract has been signed with Hughes Aircraft to explore the feasibility of using an optical communication system in deep space. Other studies of the use of lasers in distance and position measuring systems, as well as stability and guidance systems, also are being conducted.

Air Force Gemini Role May Be Increased

It now seems almost certain that *Dyna-Soar* will be abandoned in favor of an expanded Air Force role in the *Gemini* program. Defense Secretary Robert McNamara returned from his Houston and Seattle survey trip convinced that *Dyna-Soar* offers no in-orbit advantages over *Gemini* and suffers from the fact that it will carry one less man and be available a year later. He regards the difference in landing capability as relatively unimportant.

Saturns by the Dozens

Flight schedule for the *Saturn IB* booster now calls for 12 launches. First four will be development missions beginning in 1965 and ending in 1966. Remaining eight flights will be manned—with all three modules of the *Apollo* spacecraft to be used in various tests to develop operational techniques for the lunar mission.

McNamara Favors Solids in Titan III Class

Minuteman and *Polaris* have sold Defense Secretary McNamara on the use of solid fuels. He says he even leans toward favoring solid fuels in boosters of the class of *Titan III*. Key factor will be cost as compared with the *Saturn* vehicle alternative.

Bigger Buy of Tactical Missiles Foreseen

Increasing capability of the Soviet Union in the surface-to-air missile field means U.S. may put more surface-to-surface missiles in Europe to replace increasingly vulnerable tactical aircraft.

Titan II Third Stage Up for Consideration

Search for a third stage for the *Titan II* booster is not limited to *Centaur*. One proposal is for a fluorine-hydrogen third stage which would place 3000 lbs. in an equatorial 24-hr. orbit. Contractors involved are Space Technology Laboratories and Bell Aerosystems.

INDUSTRY

AMF Getting Nod for Bullpup Contract

American Machine & Foundry is believed to have the inside track in the competition for *Bullpup* second-source production (COUNTDOWN, March 18, p. 9). The contract is not being awarded to increase price competition, but because the services believe second-source production capacity is desirable.

Kellogg Gets Texas Facility Contract

M. W. Kellogg Corp. of New York City has been selected by the Space Nuclear Propulsion office to design modifications for the Air Force Nuclear Aerospace Research Facility, Fort Worth, Tex. Changes will enable testing of nuclear rocket engine systems and components under conditions approximating those they will encounter when integrated into the complete *Nerva* engine.

DOD Pleased with Aeronutronic Performance

Top DOD officials are pleased with the way Ford's Aeronutronic Division pulled the *Shillelagh* missile system out of the bog of a year ago. Chances of its moving along to the production stage now appear bright. A year ago, cancellation was a strong possibility.

INTERNATIONAL

Vickers Expected to Build Polaris Subs for U.K.

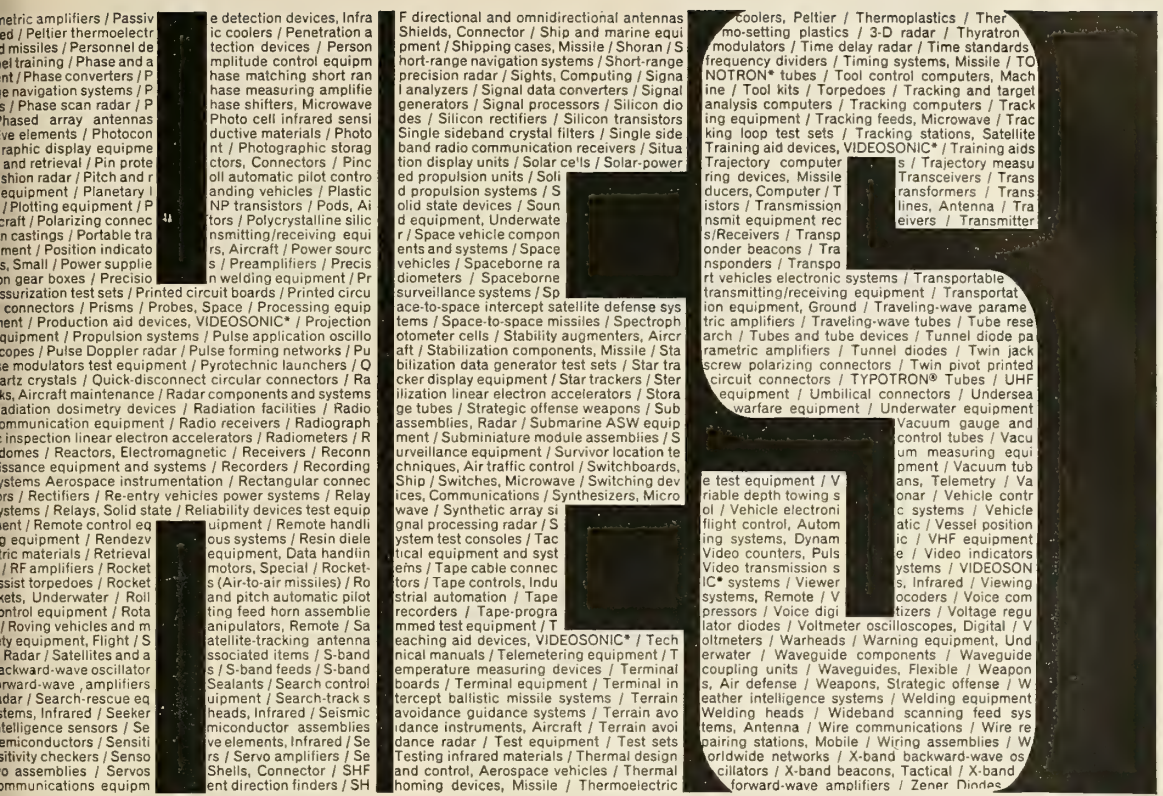
British nuclear subs for *Polaris* missiles will be constructed at two shipyards. Leading contenders are Vickers (at Barrow), Cammell Laird (at Birkenhead) and Scotts (at Greenock). Vickers is expected to be lead firm for the project.

British Leaders Confer with Industry

British government and industry leaders met last week in a top-level conference to discuss that nation's future in the aerospace field. Among subjects considered: a space plane, communications satellite program, and new guided missile projects, including antitank weapons.



553 ways to create a new world with electronics



These 553 aspects of Hughes capability cover the spectrum of advanced electronics. From accelerators to zener diodes. From microelectronics to radar for our Navy's carrier Enterprise. From the oceans' depths to deep space.

Here is breadth in depth. Research programs to probe the nature of matter. Development activities to turn new knowledge into useful paths. Productive capacity to build dependable hardware. Support services to keep these systems and products working dependably.

Over 29,000 people, including 5,300 engineers and scientists, are today at work at Hughes. Working for NASA in space, for the armed services in the maintenance of free world defense and for all of us in the betterment of human life—they are helping to create a new world with electronics.

Creating a new world with electronics

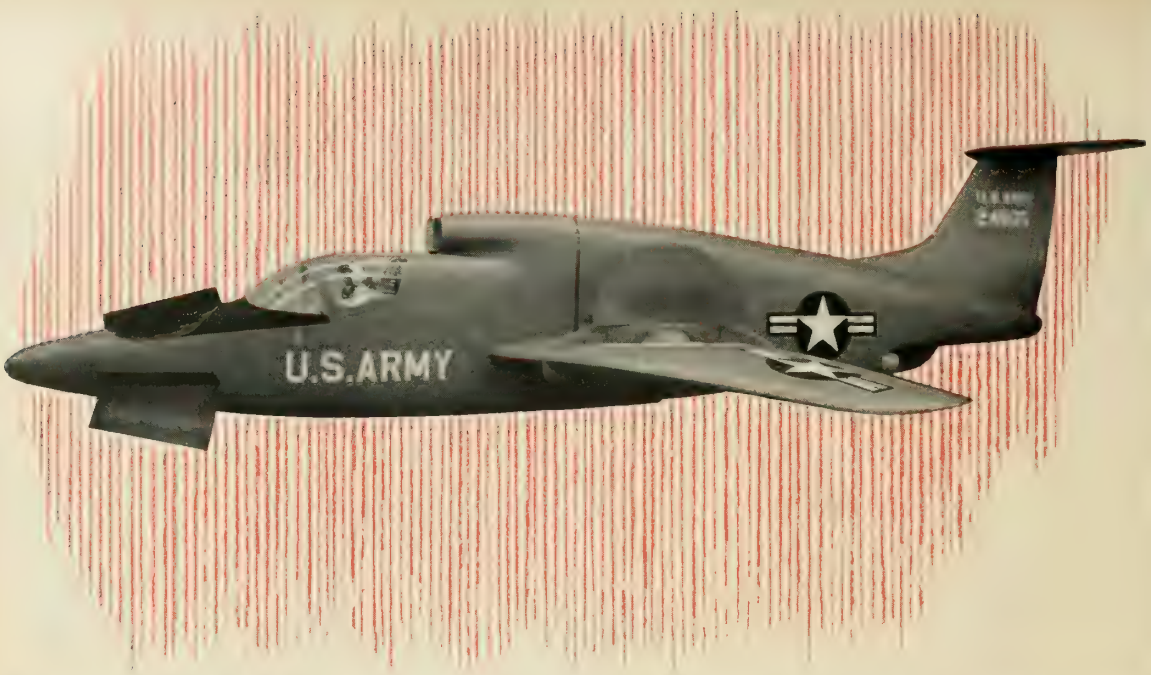
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Engineers and scientists with interest in any of the above areas are invited to inquire into the opportunities at Hughes. Numerous openings now exist. New opportunities at all levels will be created with further program expansion. Qualifications include: U.S. Citizenship, a B.S., M.S., or Ph. D. degree from an accredited university. Hughes is an equal opportunity employer.

For prompt attention please address: Mr. S. L. Gillespie, Manager, Employment & Manpower, Hughes Aircraft Company, Culver City 18, California.

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Army XV-5A* provides maximum range/payload

Scheduled to fly in mid-1963, the Army XV-5A* lift fan research aircraft will provide greater payload/range capability than any other high performance V/STOL system.

Now being designed and built by Ryan Aeronautical Company, under contract to General Electric, the XV-5A* aircraft will be powered by two J85 jet engines which drive submerged wing fans for vertical flight. This unique concept provides two to three times more lift, for a given amount of installed engine thrust, than any other high speed V/STOL design.

Result: Greater payload/range capability—less fuel consumption and need for logistic support. Because the lift fan system multiplies engine thrust by 300 percent, for vertical flight, XV-5A* engines can be sized for most efficient hovering and cruise conditions and do not have to be oversized to meet V/STOL flight requirements. These inherent and designed advantages give the XV-5A* performance which meets anticipated requirements for military missions.

* FORMERLY VZ-11

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

RYAN
AEROSPACE

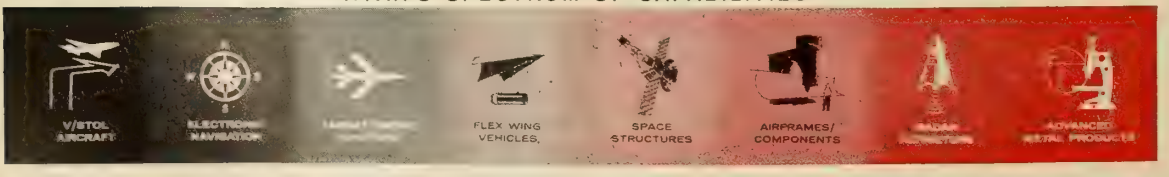


Conventional XV-5A* cockpit permits pilots to fly through transitions without moving hand or foot control positions.



Low velocity and low temperature of lift fan efflux provide major advantages for operation from unprepared sites.

RYAN'S SPECTRUM OF CAPABILITIES



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Dyna-Soar Hope Fades Away

No firm answer regarding the fate of the *Dyna-Soar (X-20)* program was released officially after Defense Secretary Robert McNamara's trip to Houston and Seattle to check on *Gemini* and *X-20* progress.

But a top DOD source made it apparent there is little hope for the project.

"The future of the program is in doubt," McNamara said earlier, "because events appear to have overtaken it. The *Gemini* program provides for two men to be placed in orbit with controlled re-entry, re-entry to land, and with an orbital capability scheduled for attainment in late 1964. *Dyna-Soar* proposed to place one man in orbit at a later date and with a lesser capability."

Acknowledging that the two programs are not completely comparable, the Defense Secretary nevertheless pointed out that each will cost about $800 million, and "I seriously question whether our nation requires that both programs be completed. We have no clear military requirement for either."

Centaur Payload Boosted

Abe Silverstein, director of NASA's Lewis Research Center, told Congress last week that design improvements have added 250 lbs. to the *Centaur's* payload capability.

Silverstein said the liquid-hydrogen upper stage will not only be able to boost the 2100-lb. *Surveyor Lander* spacecraft, but will also have a margin of a couple of hundred pounds to cover an increase in its weight.

The NASA official told a hearing of a House Space Subcommittee that the *Centaur* program now calls for 15 vehicles at a total cost of about $450 million.

He said two of the vehicles will be launched in the third and fourth quarters of this year. Six are scheduled for 1964 and seven more in 1965. After 1965, it is expected that seven or eight *Centaur* missions per year will be attempted through 1969.

Silverstein detailed for the subcommittee design changes and a rigorous testing program for *Centaur*, which Lewis officials have initiated since getting management responsibility for the project late last year.

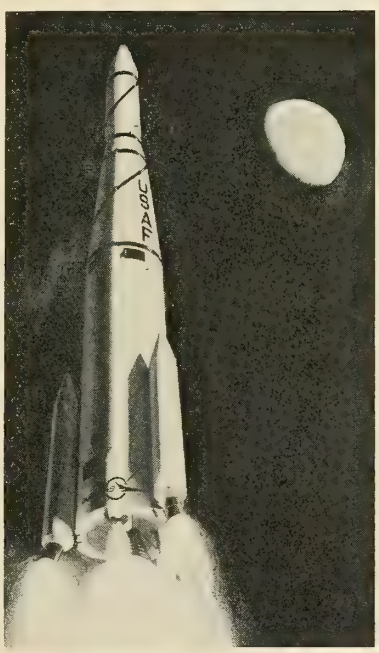
He said a large part in the increased payload resulted from a determination that a shorter time is required between the end of the first-stage *Atlas* burning and the *Centaur* ignition.

This has been cut from 45 to six seconds. He added that the quick ignition will also avoid zero-g conditions while *Centaur* is coasting.

It has also been determined, he continued, that cracking around spot-welds has permitted liquid oxygen to creep through. The welds are now being reinforced with nickel, and NASA is moving toward the use of stainless steel 310 to increase the structural strength.

Sloshing of liquid oxygen in the tanks has been cut by a factor of 10 by adding baffling and lowering tank bulkheads.

Flight trajectories will also be changed from a straight ascent to a parking orbit before *Centaur* reaches escape velocity.



'Souped-up' Thor Shown

THRUST-AUGMENTED Thor is shown in this artist's concept of the booster, being built for the Air Force by Douglas Aircraft Co.'s Missile & Space Systems Div. The booster was successfully fired for the first time March 18 (see 'Shots of the Week,' at right), and lifted a secret satellite into polar orbit. In addition to the Rocketdyne MB-3 Block II liquid-propellant engine, the TAT is equipped with three Thiokol solid motors.

Rendezvous Try Slips to '65

Two NASA scientists have said that the first U. S. attempt at space rendezvous probably will not be made until 1965.

Jerome B. Hammack and Walter J. Kapryan told the American Institute of Aeronautics and Astronautics (AIAA), that rendezvous of a manned space capsule and an unmanned object in orbit should begin with about the fifth flight in Project *Gemini*.

The *Gemini* program was originally planned as a two-year operation, with flights beginning this year and ending in 1965.

Vostoks III and *IV*, the latest manned Russian space flights, are said to have missed rendezvous by about four miles.

The first manned *Gemini* flights now are not expected before the middle of next year, and the fifth flight could not be made before 1965.

As currently planned, the U. S. rendezvous attempt will begin with launch of an unmanned *Agena-D* upper stage into orbit aboard an *Atlas* booster. The two-man *Gemini* team will be launched 24 hours later to try to lock with the *Agena-D*.

The first *Gemini* flight will be a ballistic suborbital qualification test —unmanned—expected in early 1964.

Shots of the Week

A thrust-augmented *Thor* (TAT) booster successfully launched a secret satellite into polar orbit, and three *Atlas* ICBM shots highlighted activity at missile ranges last week.

- Although the Air Force gave no details on the satellite orbited by the souped-up *Thor*, it was presumed to be of the *Discoverer* series. The launch was made March 18 from Vandenberg AFB, Calif. An *Agena* comprised the *Thor's* second stage.

The *Thor* combined liquid and solid propellant technology to increase the power from 170,000 lbs. of thrust to 330,000—almost equal to the thrust of an *Atlas*.

The three *Atlas* launches, described as routine training exercises, also went from Vandenberg AFB—on March 15 and 16, respectively.

- The first March 15 shot was made by the 565th Strategic Missile Squadron. Preliminary telemetry data indicated that part of the missile's test objectives were met.

- The second March 15 *Atlas*

firing was conducted by the 577th Strategic Missile Squadron.

● No further details were available on the March 16 *Atlas* launch, nor did the Air Force announce whether or not the second March 15 launch was a success.

● A Wing 2 *Minuteman* fired from Cape Canaveral March 18 failed 10 sec. after third-stage ignition. An old problem cropped up when the case burned through, the missile went out of control and had to be destroyed.

● The Navy fired a *Polaris A3* from Cape Canaveral March 19, but a range safety officer had to destroy the missile about 25 sec. after second-stage ignition when it went off course.

Martin Gets Sprint

Development contract for the *Sprint* anti-ICBM missile has been awarded to the Martin Marietta Corp., with Hercules Powder Co. as propulsion contractor.

Sprint, a major portion of Army's new *Nike-X* missile defense system, is designed for extremely high acceleration rates to close with incoming warheads at low altitudes. Amount of the initial contract is estimated at about $5 million.

Martin-Orlando will be a subcontractor to Bell Telephone Laboratories, the system design and development contractor. Prime contractor is Western Electric Co.

Martin was selected for the contract over competitors Douglas Aircraft Co. and North American Aviation. All three submitted results of their studies Feb. 1.

Sprint will be shorter and lighter than the 48-ft.-long *Nike-Zeus* missile, and will use a solid rocket for propulsion.

Testing will be done at White Sands Missile Range, then Kwajelein Island.

ComSat Corp. Criticized

The Communications Satellite Corp. is off to a rough start—even its new articles of incorporation have been challenged by Congress. Senate Space Committee Chairman Clinton P. Anderson (D-N.M.) said the corporation's failure to have the charter state that stock ownership will be a 50-50 proposition between the public and industry appears to be a violation of the law.

Spokesmen for the incorporators denied this, saying the law does not impose such a requirement on the communications carriers. However, the communications firms are guaranteed half the directorships of the new company.

Sen. Anderson assailed this situation, noting that it's possible under the present setup for the carriers to put up $500 and get six directorships, while the public puts up $500 million and still gets only six directorships.

A spokesman for the board of directors, which was unanimously confirmed by the committee, said the board is considering recommending a change in the law to quiet criticism.

Also challenged during hearings on the corporation were the salaries of the principal officers. Board chairman Leo D. Welch is slated for a $125,000 annual salary and President Joseph P. Charyk is salaried at $80,000.

Other expenses of the fledgling corporation were also questioned in the hearings. Sen. Stuart Symington (D-Mo.) commented that the salaries and expenses are "pretty high" for a company that does not expect to be operating at a profit for many years.

If the corporation seeks a government research contract to help sustain itself, it will first establish private research facilities.

Sen. Anderson predicted that when the NASA budget comes before



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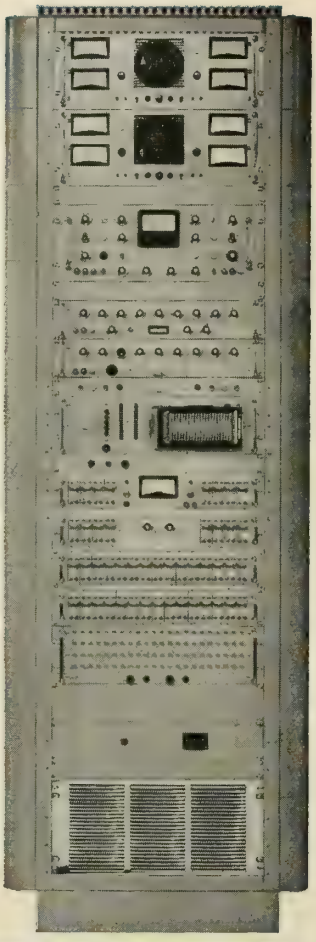


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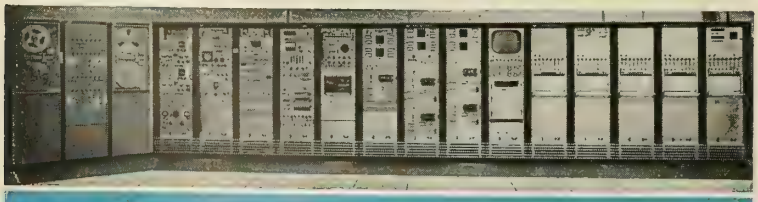
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the Space committee later this session, a "very sharp line" will be drawn between general communications satellite research and those R&D expenditures designed primarily to aid the new corporation. He noted that the corporation will probably be required to reimburse the government for work undertaken for the company's benefit.

Antimissile Motor Award Let

The Advanced Research Projects Agency of the Defense Dept. has awarded United Technology Center a six-month design study contract for a solid-propellant antimissile missile motor. The booster is to be capable of a rate of acceleration 10 to 100 times greater than conventional motors.

The motor would presumably be applicable to such missiles as *Sprint* in the *Nike-X* system. The contract, for an undisclosed amount, envisions a booster with enough thrust to hurl a payload several miles up in less than one second.

SA-4 Set for March 28

NASA this week will test for the first time the "engine-out" capability of the giant *Saturn* booster.

One hundred seconds after liftoff of *SA-4*—scheduled for March 28—the number five engine will be shut down.

Immediately, the fuel and oxygen manifold at the base of the booster will re-route the propellant from the engine to the other seven engines, increasing the burning time of each by about four seconds.

Space agency officials hope to determine whether the 1.5-million-lb.-thrust launch vehicle can complete a mission successfully if a malfunction kills one engine. Its result will also have an important effect on the *Saturn V* booster, also designed to have an engine-out capability.

NASA has already accomplished the engine-out capability during static tests of the *Saturn I*. Officials believe the vehicle could complete its mission if one or even two engines cut out.

The upcoming shot is the fourth of 10 development flights scheduled. It is expected to begin launching the *Apollo* spacecraft by late 1964.

SA-4 will be 165 ft. tall and have a maximum diameter of 21½ ft. Its liftoff weight will be 940,000 lbs. It will be launched on a ballistic trajectory, with the flight lasting seven minutes. Impact will be 220 miles down the Atlantic Missile Range.

Like the three previous flights,

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it will have inert second and third stages, with water used as ballast. Unlike the last two flights, there will be no attempt to explode the top two stages.

SA-4 will also carry for the first time a radar altimeter, four solid-propellant retro-rockets and a missile trajectory-measuring transponder.

The latter is designed to help the Atlantic Missile Range develop a more accurate tracking system.

NASA Shuffles Personnel

NASA has announced a shakeup in its headquarters organization designed to speed the flow of results of its R&D activities into the civilian economy.

The position of Assistant Administrator for Technology Utilization and Policy Planning has been established, and Dr. George L. Simpson has been appointed to the post. Simpson formerly served as Assistant Administrator for Public Affairs.

Reporting directly to Simpson will be NASA's Office of Industrial Applications (M/R, March 18, p. 15).

It will be re-named the Office of Technology Utilization and Louis B. C. Fong will continue as its director.

It has been known for some time that NASA officials were not pleased with results of their Industrial Applications program, which is charged with making technological breakthroughs available to U.S. industry.

One of Simpson's jobs, the announcement said, will be to develop closer working relationships between universities and industry "to return results of space research to the economy on a regional basis and enhance national technological growth."

Van Allen Reverses Opinion

Dr. James Van Allen now agrees that the artificial radiation belt created by the U.S. July 9, 1962, nuclear explosion will last at least 10 years.

Previously, Van Allen had been at odds with other U.S. scientists on results of the high-altitude detonation.

While they reported in September, 1962, that the effect would be intense and long-lasting, Van Allen contended that the radiation would disappear fairly quickly.

The scientist told a symposium sponsored by the Goddard Space Flight Center recently that "actual observations of the radiation belt by several satellites" have disproved this theory.

He said that, while the outer edge of the radiation belt has disappeared



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rapidly, the heart of the belt—some 1200 mi. above the Earth's equator—seems very durable and may last a decade or more.

Gemini Drop Tests Slated

Grueling tests of the two-man *Gemini* capsule were scheduled to begin this week at the Pacific Missile Range.

The test series involves parachute drops into the Pacific of a 5000-lb. *Gemini* mockup, mounted on a 1500-lb. wooden sled, from a C-130 plane. PMR support will include radar, telemetry, photo coverage and provision of ships to recover all gear.

Goal of the series is to check out the reliability of the parachute system and to test the capsule's ability to remain afloat.

The tests are scheduled to continue for the next five or six months. First manned flights in the *Gemini* program are planned for 1964, after unmanned, suborbital test flights from Cape Canaveral.

Life-Support Contract Due

NASA will award a contract this week for research, design and construction of a prototype six-month life-support system capable of supporting four men.

Ten companies have submitted bids to the Langley Research Center, which is contracting for the Office of Advanced Research and Technology. They are: General Electric, General American Transportation Corp., General Dynamics/Astronautics, North American Aviation Systems Information Division, Aerojet General, Boeing Co., Martin Marietta Corp., United Aircraft Hamilton Standard Division, Bendix Co., and AiResearch Mfg. Co.

MSC Gets Boilerplate Apollo

The first flight-rated boilerplate model of the *Apollo* Command and Service modules and the escape tower were routed to Houston's Manned Spacecraft Center last week.

The 55-ft.-tall structure was originally scheduled to go directly to Marshall Space Flight Center in Huntsville, Ala. to be mounted on a *Saturn* rocket for vibration tests.

Manned Spacecraft Center officials diverted the model to Houston for calibration and instrumentation studies before it goes to Marshall. North American Aviation, Inc., trucked it from Downey, Calif.

Assembly also includes the mating flange for the *Saturn I*. Boilerplate flights of the *Apollo* Command and Service modules will begin in '64.

More Blue Scout Launches Due

The Air Force will resume *Blue Scout* launches from Cape Canaveral in May on a one-a-month basis. Nine shots are planned in the series. Scientific payloads prepared by Cambridge Research Center and the Air Force Special Weapons Center will be sent 30,000 to 80,000 mi. to study radio noises, solar winds and radiation hazards. Payload weight will range between 30 and 60 lbs.

The unguided booster will be similar to the *Blue Scout, Jr.*, but will have a new fourth stage manufactured by Atlantic Research Corp. Other stages are manufactured by Allegany Ballistic Laboratory, Thiokol Chemical Corp. and Aerojet-General Corp. Prime contractor for the entire assembly is Chance Vought.

Air Force spokesmen said the long delay in resuming the *Blue Scout* program at AMR was caused by a re-tooling job for the rocket.



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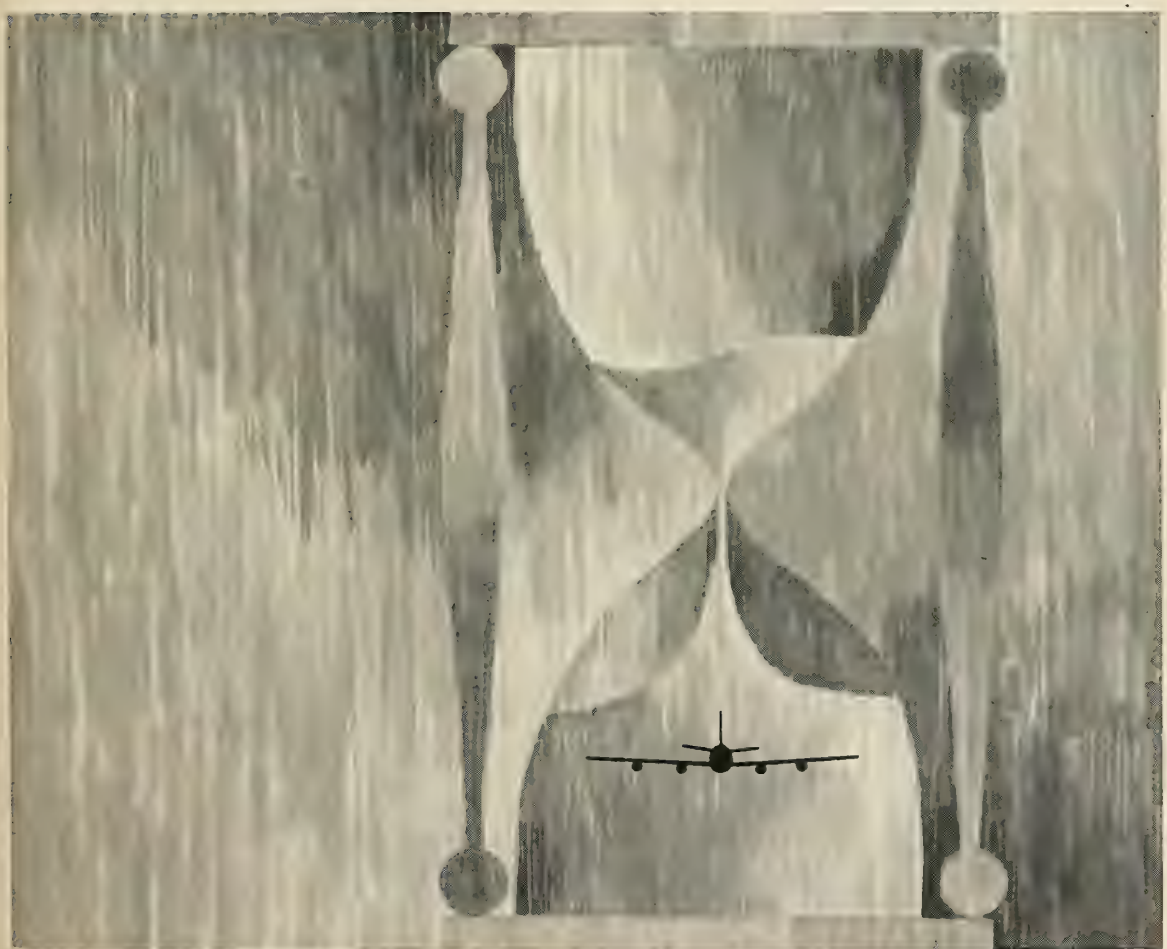
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AEROSPACE GERIATRICS

...AND WHAT DOUGLAS IS DOING ABOUT IT

In aircraft parts, as in men, excessive stress accelerates the aging process. And stress aging per hour varies for each aircraft. Yet the present way of determining servicing schedules is based primarily on hours flown. □ Now Douglas researchers have developed a device which, when installed on an aircraft, provides a more positive method of determining check-up times for aircraft parts. □ Called a "Service Meter," and weighing less than 1½ pounds, the Douglas unit computes the accelerations encountered by its aircraft in relation both to number and severity. It allows servicing to be performed on the basis of the true *work age* of parts, and will be an important aid to maintenance procedures that keep aircraft young. □ Research like the foregoing has helped build the Douglas reputation for producing the world's most reliable aircraft.

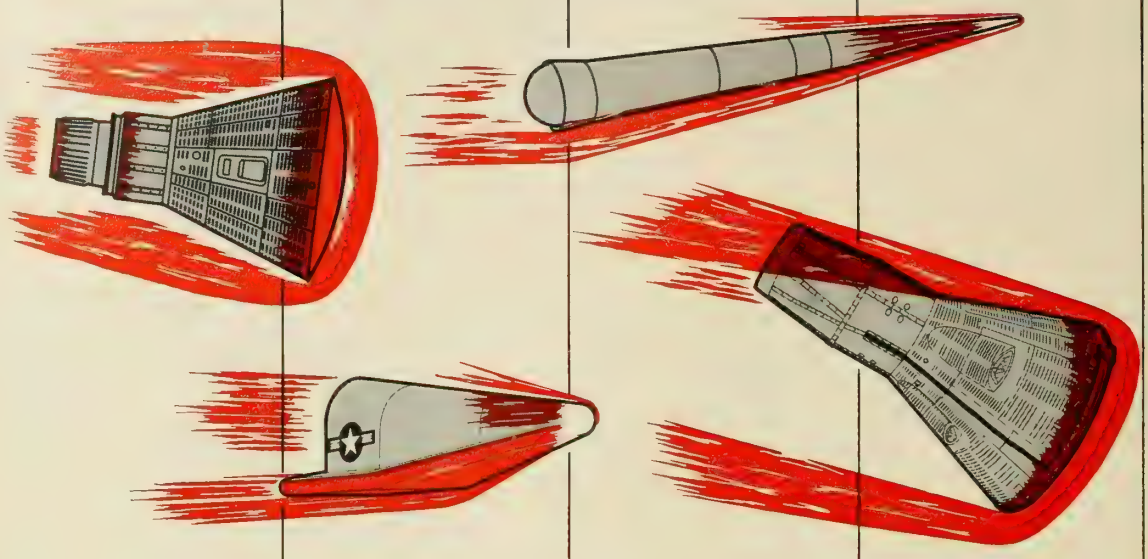


The "Service Meter" is the result of one of the more than 500 research programs under way at Douglas. Some relate to present programs like SATURN S-IVB, ZEUS, DELTA, DC-8F and SKYHAWK. Others are oriented on great aerospace developments of the future.

DOUGLAS

EARTH ORBITAL REENTRY

Four spacecraft programs, each engineered to explore diverse techniques for earth orbital reentry, are underway at McDonnell.



MERCURY, America's first manned orbital spacecraft, utilizes a non-maneuverable ballistic reentry. After retro-rockets slow the spacecraft to bring it out of orbit, reaction jets position it for reentry. Mercury's ballistic shape maintains alignment with the drag vector as it follows a ballistic path through the atmosphere to drogue chute deployment at 21,000 feet. Final descent to an ocean landing is accomplished with a 63-foot ring-sail parachute.

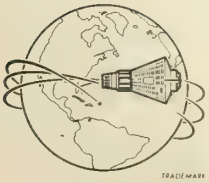
ASSET, an instrumented, unmanned, winged vehicle, will reach speeds of 13,000 miles per hour in sub-orbital flights at altitudes of over 40 miles. This space research program will provide for study of glide reentry technology, refractory materials fabrication experience, and accelerate the development of maneuverable reentry techniques. A parachute landing system enables recovery of vehicle and data package for post flight analysis of test data.

AEROBALLISTIC is a word coined to describe the lifting body concepts proven by flights of McDonnell hypersonic missiles from Cape Canaveral in early 1959. The test flights demonstrated precise atmospheric control, the aerodynamic efficiency of an Aeroballistic vehicle and were the first breakthroughs in the design of maneuverable reentry spacecraft. Space missions utilizing an Aeroballistic type vehicle would terminate with a conventional runway landing.

GEMINI is a two-man orbital spacecraft for long duration and rendezvous missions. Upon reentry, the crew will position Gemini's off-set center of gravity with attitude control jets to re-orient the drag vector and create a lift component. This lift will enable the crew to maneuver Gemini to any point in a 28,000 square mile landing area. A paraglider will be deployed in later flights, enabling precise astronaut control of the glide to the landing field.

With MERCURY, ASSET, AEROBALLISTIC and GEMINI Spacecraft, McDonnell is perfecting reentry techniques, shapes, materials and manufacturing processes necessary for the achievement of U. S. leadership in space.

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- *Asset is being developed and built under the sponsorship of the Aeronautical Systems Division of the Air Force Systems Command.*
- *Aeroballistic vehicles were developed and tested under contract with the U.S.A.F. and development is continuing with company funding.*

ST. LOUIS

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Missiles and Rockets Volume XII, Number 12 March 25, 1963

MILITARY SYSTEMS ISSUE

DURING THE PAST YEAR, the reorganization of the Department of Defense has had growing impact on the U.S. Government and the missile/space industry.

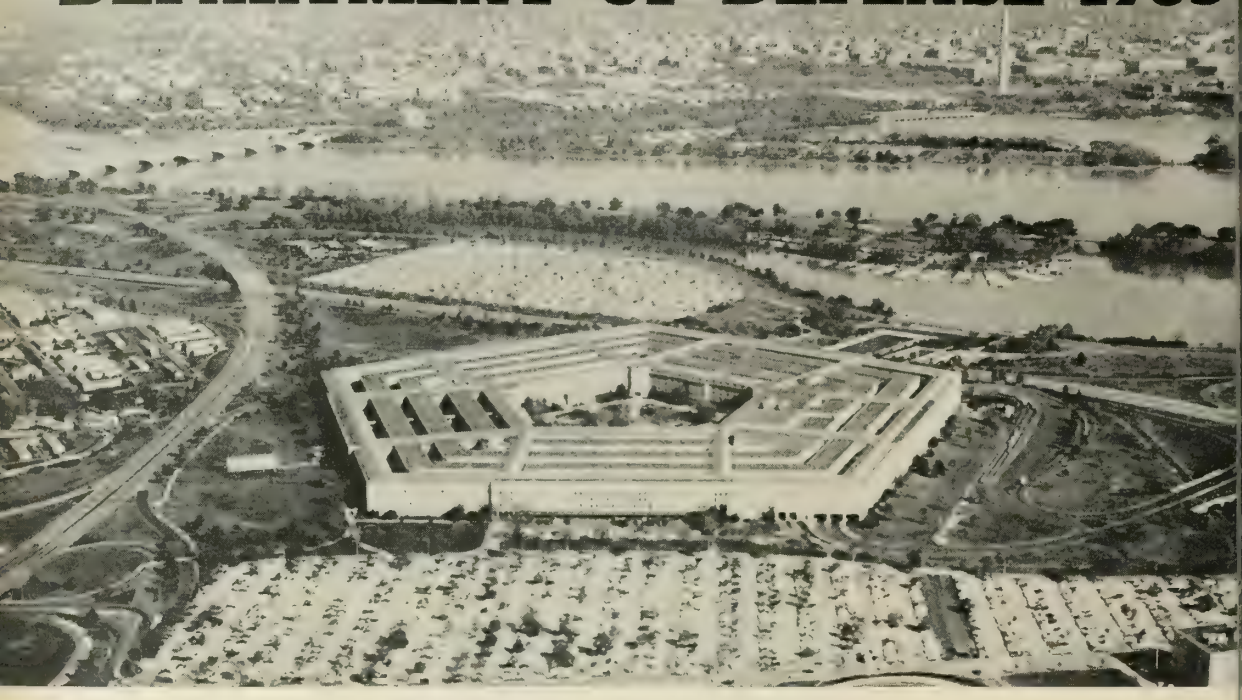
In this special issue, the editors of *Missiles and Rockets* present the first analysis from an industry point of view of the changes within the Pentagon.

The first section of the issue is a report on the reorganization and how it has affected DOD policies and planning, procurement, and research and engineering.

Part II tells how DOD approves a weapon system, how industry operates at the DOD level, how other Government agencies affect DOD decisions, and how critics assess the reorganization.

Part III covers in detail the offices and agencies involved in Defense decision-making.

DEPARTMENT OF DEFENSE 1963



The New Shape of U. S. Defense

McNamara's dynamic leadership has wrought sweeping changes—and stirred both praise and fears; a look at the pros and cons

ROBERT S. McNAMARA—46, graduate of the University of California and Harvard, Phi Beta Kappa, squash player, colonel in the Air Force reserve, elder of the Presbyterian Church and former president of the Ford Motor Co.—is without question the most effective Secretary of Defense yet to hold office. He also is the most controversial.

The McNamara reorganization of the Dept. of Defense along more businesslike lines has re-shaped the U.S. military and its relationship with industry. Congress, the individual military services and industry agree with much of what McNamara has accomplished. Yet, both in some general areas and specific detail, there is strong controversy.

What is not generally understood is that in centralizing management of the vast defense establishment, Secretary McNamara has not acquired any new powers. Employing the brisk efficiency brought from Ford to implement the powers already given him, he is the first to do what Congress directed that the Secretary of Defense should do.

Last week, in his white-walled office in the Pentagon's E Ring, the Defense Secretary summed up his management philosophy in a single, neat phrase:

"I believe a leader should lead."

There is no doubt he is doing exactly that. There are no questions in Congress or the military about who is the leader of McNamara's band. Any argument is about what he is doing—not whether he is doing it.

● **Pros and cons**—Last month after Secretary McNamara completed his testimony on the Fiscal '64 budget, House Armed Services Committee chairman Carl Vinson (D-Ga.) told him: "It is by far the finest document, giving a complete, minute breakdown of the defense of the country, that has ever been submitted to this committee since its creation."

McNamara's intimate, detailed knowledge of the department he runs seldom fails to impress Congress. But critics elsewhere, when they talk about the breakdown of the defense of the country, are not being so kind.

Much of this criticism is based on a misunderstanding of what McNamara has accomplished in his more than two years in office. Much of it is based on fears of what will happen to the quality of the nation's future weapons systems and its armed forces as a result of the McNamara reorganization. And much of it stems from the Secretary's failure to explain what he is doing because he has been too busy doing it.

McNamara impressed his Congressional listeners last month by opening his budget testimony with a clear, keen rundown of U.S. foreign policy in seven different areas of the world and with a

concise analysis of the strengths and weaknesses of the Communist bloc.

This should not have been surprising. The defense budgets in this Administration are laid out in direct relation to the nation's international position. The foreign policy requirements are used to set the force levels for the combat services. These then are translated into programs and requirements.

● **Packaging**—Basic to the McNamara reorganization of the Pentagon is the grouping of similar combat and support tasks into program packages—strategic retaliatory forces, continental air and missile defense forces, general purpose forces, airlift/sealift forces, research and development and others. Under this concept, the budget is established for the program package as a whole, not by individual services. Air Force *Minuteman* funding is considered in the strategic retaliatory force package right along with the Navy's *Polaris* budget. All costs, for a five-year period, are considered—maintenance, personnel, equipment.

To understand this program packaging is to understand the reason for the increasing centralization of power in Secretary McNamara's DOD staff. For it is only possible to determine the size of the package and the makeup of its individual service components at a level higher than the individual services.

With this in mind, the increasing importance of the Joint Chiefs of Staff and of McNamara's civilian advisors—such as Dr. Harold Brown, director of research and engineering—is evident. But in the end, it is the Secretary himself who must make the final decisions and recommendations to the President.

● **Military doubts**—This is one of the areas of controversy and fear—fear that primarily military decisions are being made by a civilian. It is one of the bones at which Congress has worried the most.

But the fear frequently is expressed without consideration of the dual nature of the Dept. of Defense and of the Secretary's job.

Secretary McNamara is head both of the nation's combat forces and of the organization which supports those forces. All of the combat services now report directly to the Joint Chiefs of Staff and through them to the Secretary.

The service secretaries and the civilian hierarchy at the DOD level are managers in the support, not the combat organization. Thus, the military input on operations is direct, without intervening levels of civilian command.

A more proper question is whether there is sufficient military input on the planning side, when force levels are drawn up and hardware requirements for the forces are determined. It is in this role that military men most frequently feel they are being overlooked.

McNamara scoffs at such fears, pointing out that he consults frequently with the Joint Chiefs and cannot remember a single instance when he overruled a unanimous decision of the JCS.

● **Answering industry**—But it is in this same area of research and development that industry voices its most vigorous criticism of the McNamara regime. The continuous program reviews and the heavy emphasis on cost effectiveness, say these critics, are forcing industry to propose only minor advances in the state of the art.

McNamara says this simply is not true. Too many systems in the past, he points out, have been pushed into production before the technical difficulties and cost factors have been studied sufficiently. As a result, both time and money have been lost, as well as reliability and dependability. He considers *Skybolt* a prime example.

What industry must learn, McNamara suggests, is the difference between the various areas of research and development. DOD now breaks its research and engineering budget into four major fields of interest in this regard.

They are Research, Exploratory Development, Advanced Development and Engineering Development. (An explanation of these is found on p. 80). The last category covers systems approved for development, prior to production and deployment to the combat forces.

Secretary McNamara points out that only in this category does DOD insist on freezing of costs and designs. Of the Fiscal '64 research and engineering budget of $5.9 billion, some $1.9 billion is alloted to projects in engineering development.

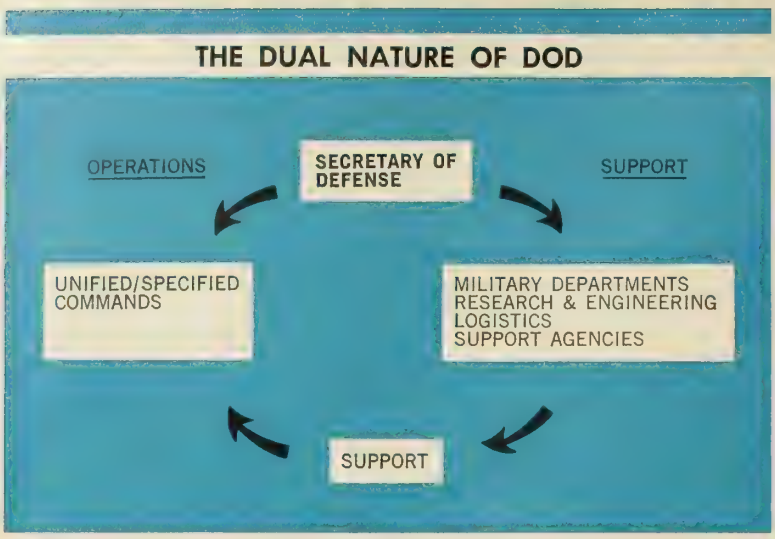
This leaves $4 billion in research and development funds not associated with systems approved for development. This $4 billion covers the areas where DOD expects industry to push for major advances in the state of the art.

"In the early stages—basic research, exploratory development, and advanced development—we don't have operational requirements and the contractor can reach as far out into the blue as he wants to," Secretary McNamara told MISSILES AND ROCKETS.

It is in the later stages of research and development that McNamara wants emphasis placed on reliability and dependability by means of cost and technical studies. That has been stressed by

THE LEADERS—President Kennedy flanked by (left to right) Marine Commandant Shoup; Army Chief Wheeler; Navy Chief Anderson; Secretary McNamara; JCS Chairman Taylor; Deputy Defense Secretary Gilpatric; and AF Chief LeMay at Florida meeting.





inauguration of the so-called "program definition phase."

"Poor planning, unrealistic schedules, unnecessary design changes, and enormous cost increases over original estimates have continuously disrupted the efficient operation of our research and development program," McNamara says. "Most of these difficulties have resulted from inadequate prior planning and unwarranted haste in undertaking large-scale development, and even production, before we have clearly defined what is wanted, and before we have clearly determined that a suitable technological basis has been developed on which to build the system. We have often paid too little attention to how a proposed weapons system would be used and what it would cost, and finally, whether the contribution the development could make to our forces would be worth the cost."

● **Sharper control**—To his plans for improved cost effectiveness in the R&D field, McNamara has added a five-year program to reduce procurement and logistics costs.

This is reflected in the establishment of such DOD "super-agencies" as Defense Supply Agency and Defense Communications Agency.

It still is too early to fully determine the effect of these. DSA generally seems to be effective in its buying of common items for all three services. But at least one operational commander says he has to "bootleg" parts directly from the manufacturer to "by-pass the DSA bottleneck" and keep his missiles operational.

Obviously, there still are areas where McNamara theory has not yet become McNamara fact. This is partly because the services themselves have not yet fully grasped the full implications of the DOD reorganization.

Critics of "over-centralization" of the Pentagon under McNamara must be careful to define their terms. The planning and policy function—that is, determination of force levels and the technical requirements of the weapons systems needed by the combat arms—are indeed firmly in the grasp of McNamara and his staff.

"If we are talking about combat operations, that is clearly a matter that in my opinion the Chiefs have primary responsibility for, and under normal circumstances would make the day-to-day decisions with respect to," McNamara says. "If by operation you are considering such questions as what force level is appropriate in total for Fiscal 1968, I personally believe this is a basic policy decision that the Secretary must play a major role in making, and it must be made in relation to the total objectives of our nation, particularly its foreign policy objectives."

● **Services buy**—Responsibility for most of the procurement decisions in terms of contractor selection still remains at the level of the services.

The services no longer have much say in what weapons systems they will buy but they still play a large role in determining who will build them. There are obvious exceptions. But Secretary McNamara can remember participating in only two source selections.

An official from Ford once called McNamara to berate him for a contract decision which awarded the procurement of a Ford-designed "Jeep-type" vehicle to Willys. McNamara, who had been Ford president during the vehicle's design stage, hadn't even heard of the contract.

"I don't even see 99% of the procurement decisions," he says.

● **Political push**—To charges that politics are playing an increasing role in source selection, top DOD officials will agree that more political pressure is being brought to bear these days but insist it has had little influence in awarding of contracts.

Again, there are obvious exceptions, but one high DOD staff member points out: "What industry should remember is that political pressure is nothing more than business pressure brought to bear through political channels."

● **Elusive pyramid**—McNamara frequently talks of the day when he can pass many of the decision-making responsibilities back to the individual services. He told the House Armed Services Committee recently that he sees the DOD decision-making process as a pyramid in which he hopes to push as much of the decision-making as possible to the bottom.

But it is apparent that under the reorganized DOD structure much of the responsibility must remain at DOD level. Force levels, for example, can be determined only there. The same is true of basic policy decisions.

The only area remaining in which the decision-making can be passed downward once again is in the area of research and development. Once the services learn the new ground rules of cost effectiveness and other facets of program definition, they might again have more say in what weapons systems they will buy.

To the question of whether one man—or two, if you include Deputy Secretary Roswell Gilpatric—really can make all the decisions required of SecDef, McNamara has a ready reply: "They say I have arranged it so nobody can take my place. That's a lot of baloney. All the information is here. Succeeding secretaries can just change the figures."

When it's remembered that the Secretary is talking about policy decisions, not the thousands of individual decisions on procurement, he does make the task seem less ominous. Certainly, his successor will find the Pentagon better organized than ever before.

One of the most frequent complaints heard inside the Pentagon itself is that McNamara is running the place like the Ford Motor Co. It is a point well taken. In one recent 45-minute interview, the Secretary used the word "Ford" five times.

And an over-worked DOD staff member in one office complains: "We have just four men in this office. You know why? Because there were just four men in the same office at Ford.

But to cost-conscious Robert McNamara, comparison of Pentagon efficiency to Ford efficiency is a compliment; not a complaint.

That's the way DOD is run these days—on a business-like basis. ■

Planners Now Stress Final Results

New planning-programming-budgeting approach gives clearer picture of overall effort; McNamara aims to raise profit level

"We must first determine what our foreign policy is to be, formulate a military strategy to carry out that policy, then build the military forces necessary to successfully conduct the strategy." —Secretary McNamara

THE FORCES NECESSARY to successfully conduct this country's military strategy will cost an estimated $53.7 billion in the next fiscal year, of which approximately $18.6 billion is for missile/space efforts.

Breaking of this figure down into more digestible bits involves a combination of new budgetary approaches, strategic considerations, technological advances and political developments.

Greater emphasis on the results, rather than the engineering techniques used to attain those results, dominates the new Dept. of Defense attitude toward building a structure of military forces.

Robert McNamara, a man who believes in active leadership, is convinced we have reached a point of diminishing returns in some areas of defense spending, but he sets no ceiling on expenditures needed to maintain force levels.

● **Budgetary approach**—The present DOD budgetary approach, formulated by McNamara and DOD Comptroller Charles Hitch, is the basis for an entirely new mode of thinking in the Pentagon. Instead of having budgets considered by service or individual system, the planning-programming-budgeting system has been introduced, seeking a maximum of interplay between the mission-related systems, regardless of the cognizant service.

For example, the *Polaris* submarines are funded in a category separate from the rest of the Navy's shipbuilding program because of their strategic role. They are thus put in the same category as the Air Force's B-52 and B-47 aircraft and the strategic missiles. This "Strategic Retaliatory Force" is a combination of weapons systems, military services, and all supporting elements needed to carry out the task of retaliation.

Any change in a major category would be referred to all affected organizations for comments.

Although he ultimately cut over $13 billion from the budget requests of the services before submitting the final DOD request for $53.7 billion in new obligational authority, Secretary McNamara told the House Armed Services Committee he would have approved the original $67-billion budget total without hesitation if the defense of the country warranted it. He said nearly all the sacrificed requests were for items which did not affect the force structure of the military.

This year's FY '64 budget, in contrast to last year's requests, is based on an existing program philosophy. The present budget system was introduced last year, and resulted in some initial confusion—but has since produced a much clearer picture of the overall defense effort than was ever achieved before.

The planning-programming-budgeting system looks at the defense effort as a whole and enables the Administration to determine major program priorities with meaningful data showing the effects on the entire program. McNamara contends that this balance of forces can be achieved only at DOD level, and he has very little argument on that score.

The number of interdependent decisions is quite high, and here the Joint Chiefs of Staff and the SecDef play a major role. At the same time, while he feels this unified planning, programming and decision-making are essential on such broad matters, McNamara also believes the actual operation of the program should be managed on as decentralized a basis as possible.

This condenses to a philosophy of centralized planning and decentralized operation.

● **Program changes**—A program change proposal to alter an existing program in some way can be initiated by any one of the military departments. The procedure went into effect last July, and up until the time of the budget preparation in October, several hundred program change proposals were made. If an individual change is proposed involving an amount over $10 million in one year or $25 million over the total cost of the program, the specific approval of the SecDef is required.

The JCS can comment on any such proposed change, and can also initiate any changes they feel are called for. There have been no basic changes in this procedure so far, and an annual review of major programs during the summer will take place to relieve the top administration of the burden of considering all the changes during budget preparation time in the fall.

There has also been no change in the five-year program package system, although some modifications have been made in the procedure involved. Program change review each summer and the budget review each October and November will henceforth be separate processes, but a program change can be proposed at any time. In April, the JCS will voice their views on what the five-year force structure should be. The results of these periodic evaluations and proposed changes and force levels are then considered by the SecDef in his final budget preparation.

● **Trends in weapons**—Whatever the configuration of the hardware bought by DOD in the future, it will almost certainly fit McNamara's concept of what the weapon should be in terms of cost and effectiveness, or it will never see the light of day.

Despite this fact, which may prove painful for some companies, the McNamara budget for future weapons will be keyed to a prime industry motivation: profit.

The defense secretary feels the present level of 3% to 3½% of profit for industry as a return on sales is too low. As an incentive to industry, he plans to try cutting the remaining 96% or 97% as much as possible, using some of the savings to boost industry profits.

If industry can clarify for DOD what it wants done, then industry will share the rewards of a better system. If DOD can cut five points from the cost of a system, it will gladly give one or two of those points to industry as a profit boost. The system may or may not follow the guidelines laid out by

the Logistics Management Institute report (see p. 117).

As for the configurations of the weapons to be used, McNamara is leaning heavily on a wide variety of missile types, employing different launch points, trajectories, re-entry tactics, and speeds. He sees little real value in high-speed launch vehicles such as the RS-70 or B-52 firing *Skybolt*-type missiles. Nevertheless, he has put out a suggestion that AF undertake studies of a bombing system alternative to the gravity bomb.

He feels the nation is not putting all its eggs in one basket with missiles, and has a strong case to back up the argument. As he described his thinking before the House Armed Services Committee, it indicates a larger and larger budget for varied missile types:

"There are three or four variables in the systems used for strategic attack purposes. One is the character of the launch platform; it is either fixed or moving . . . a second is the type of weapon; it is either a gravity bomb or it is a missile. When we talk about putting all our eggs in one basket, I don't believe it is correct to say that the program we are proposing does that. We have a fixed platform system, that is, the *Minuteman;* and we have a moving platform launch system in the *Polaris.*"

"One missile is not like another missile from the point of view of the defender. They come in at different angles, they come in at different speeds, they come in with different re-entry warheads, they come in with different penetration tactics. Our programs are designed to confront the defender with a wide variety of defense tasks.

"The problem of miscalculation and go/no-go applies to both aircraft and/or air-launched missiles and to missiles launched from the ground or below the seas. There comes a point, with a B-52 force, when they reach a point of no return and must proceed to the target. The time from this point to detonation of the aircraft's bombs or return to base is actually greater than the time between the decision to launch a land-based or sea-based missile and the time it arrives at its target. So the use of a *Minuteman* missile or a *Polaris* missile allows more decision-making time than the use of a B-52 bomber, for example, that is in relation to detonation of the warhead on the Soviet target."

This capsule statement of weapon-system philosophy shows considerable DOD dependence on relatively invulnerable, high-reliability missiles of widely varying types. Current DOD programs emphasizing advanced ballistic re-entry systems, high-speed re-entry, and similar penetration aids bear out this conviction.

• **Current spending**—The FY '64 request for new obligational authority exceeding $53 billion will bring total obligational authority for the year to $55.2 billion. The $18-billion-plus for missiles and space is not in any specific program package, but is found scattered among the many military programs.

The major budget categories are: Strategic Retaliatory Forces, Continental Air and Missile Defense Forces, General Purpose Forces, Airlift and Sealift Forces, Reserve and National Guard Forces, Research and Development, General Support, Civil Defense, and Military Assistance.

In the pending FY '64 budget, there is a generally conservative trend in both missiles and military space; missiles hold at about the same level as FY '63, and military astronautics increases very slightly. Increased pay and benefits to members of the armed forces are taking the bulk of the $2.4-billion increase in the overall defense budget.

The strategic retaliatory forces, budgeted at $7.3 billion, have dropped from their previous year's estimated $8.5 billion, which in turn was a drop from the FY '62 level of $9.1 billion. Continental Air and Missile Defense Forces are budgeted at $2.0 billion, up from the current level of $1.9 billion.

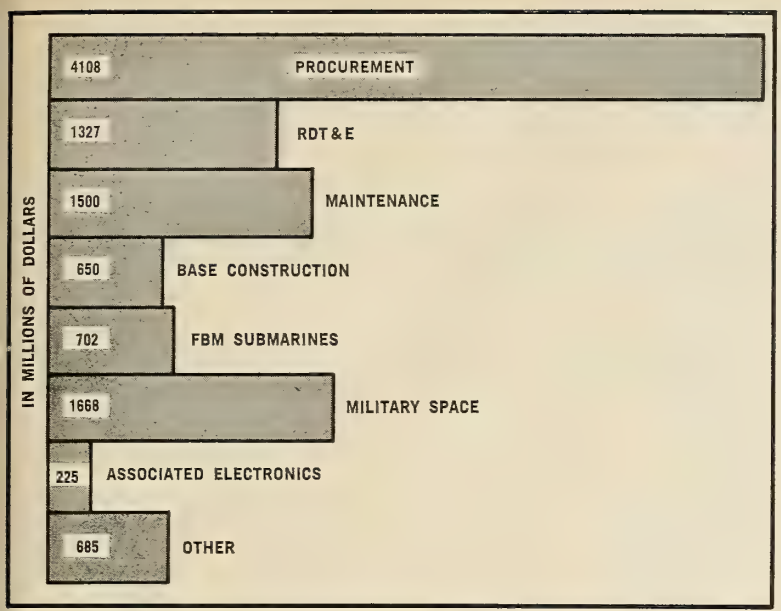
General Purpose Forces have risen for the third straight year, from $17.5

DEPT. OF DEFENSE FINANCIAL SUMMARY (In Billions of Dollars)

(From official record of testimony before House Armed Services Committee)

	FY 1961 Actual	FY 1962 Original	FY 1962 Final	FY 1963 Curren Estimates	FY 1964 Budget Estimates
1. Strategic Retaliatory Forces		$ 7.6	$ 9.1	$ 8.5	$ 7.3
2. Continental Air and Missile Defense Forces		2.2	2.1	1.9	2.0
3. General Purpose Forces		14.5	17.5	18.1	19.1
4. Airlift/Sealift Forces		.9	1.2	1.4	1.4
5. Reserve and Guard Forces		1.7	1.8	2.0	2.0
6. Research & Development		3.9	4.3	5.5	5.9
7. General Support		12.3	12.7	13.7	14.6
8. Civil Defense			.3	.2	.3
9. Military Assistance		1.8	1.8	1.6	1.6
Proposed Legislation for Military Compensation, etc.					.9
Total Obligational Authority*	$46.1	$44.9	$51.0	$52.8	$55.2
Less Financing Adj.	−3.0	−1.2	−1.6	−1.5	−1.5
New Obligational Auth.	$43.1	$43.7	$49.4	$51.3	$53.7
Adj. to Expenditures	+1.6	+1.0	−1.2	−1.3	−1.3
Total Expenditures	$44.7	$44.7	$48.2	$50.0	$52.4
TOA by Dept. & Agency					
Army	$10.5	$10.6	$12.8	$12.2	$13.1
Navy	12.8	12.5	14.9	15.2	15.5
Air Force	20.1	18.7	20.0	20.9	20.7
Civil Defense			.3	.2	.3
Defense Agencies	.3	.4	.3	1.8	1.9
Retired Pay	.8	.9	.9	1.0	1.2
Military Assistance	1.5	1.8	1.8	1.6	1.6
Proposed Legislation					.9
TOTAL*	**$46.1**	**$44.9**	**$51.0**	**$52.8**	**$55.2**

* Excludes cost of nuclear warheads.



TOTAL REQUEST for missiles and space in Defense Dept. Fiscal '64 budget.

billion in FY '62 to subsequent annual levels of $18.1 billion, and now $19.1 billion.

Similarly, budget estimates for RDT&E have increased for three years running—FY '62 at $4.3 billion, followed by $5.5 billion in Fiscal 1963, and a FY '64 request of $5.9 billion. General Support has also gone up for the third year in a row—$12.7 billion in FY '62, estimated $13.7 billion in FY '63, and an FY '64 request for $14.6 billion.

As a measure of comparison for our defense budget, defense officials presented Congress with estimates of the Soviet Union's spending level in military preparations. DOD Comptroller Charles Hitch, noting that the USSR overall effort is roughly comparable to ours, said nevertheless that in proportion to their gross national product, the Soviet effort is 50% greater than ours. Whereas we devote about 10% of our GNP to defense, the Soviet figure is about 15% of their GNP.

• **Military space**—Overall DOD expenditures for space have increased from $1.62 billion for the current fiscal year to $1.67 billion requested for FY '64, thus comprising about 20-25% of the total RDT&E budget. A large portion of this effort is the AF *Discoverer* program, including a space technology satellite program which placed 13 payloads in orbit last year, containing about 65 experiments. Other phases of the military space program include warning and reconnaissance satellites.

The *Dyna-Soar X-20* program, now funded at $125 million for FY '64, was originally the object of a $150-million request by AF, but was cut. First flight of the *X-20* is now slated for November, 1965, but Secretary Eugene Zuckert of the Air Force told the Congress no consideration is being given to adding impetus to the program, the inference being that the reverse is true.

By contrast, AF Chief of Staff Gen. Curtis LeMay told the House Armed Services Committee he is convinced "the Russian space program is entirely military." He noted that our own space program is at about a 3-to-1 ratio, in terms of dollars, in favor of the peaceful aspects of space.

LeMay added, however, that it is currently impossible to accurately define an offensive weapon for use in space that will be more efficient and less costly than one capable of the same mission from the ground or air.

On the defensive side, DOD expenditures for space amount to 40% of the DOD space effort, when measured in terms of dollar expenditures.

• **Missile forces**—Prime outlay for missiles is in the *Minuteman* and *Polaris* categories, with other major systems drawing heavily on the overall funds available. *Atlas* is holding steady, *Titan I* is now fully deployed, and *Titan II* will be fully procured by the end of FY '64. These missiles will remain in inventory throughout the existing five-year program—with the possibility, however, that some *Atlas* missiles will phase out.

Minuteman is increasing in numbers at a fairly rapid pace. Eight hundred are programmed through this year and an additional 150 missiles are now requested, bringing the official total to 950. There is strong indication, however, that the ultimate number of *Minuteman* missiles will reach 1300.

Polaris is still programmed at 41 submarines with a total of 656 missiles. The $695-million item in the FY '64 budget proposal providing full funding for six additional submarines accounts for the last of the fleet, since all others have been fully funded. Deployment in the Mediterranean is expected very soon, and ultimate deployment in the Indian and Pacific oceans is planned.

In missile defense, the $450-million FY '64 request will initiate the *Nike-X* program and continue the *Nike-Zeus* and *Defender* programs. The *Zeus* system will be continued at a level of $89-million during FY '64, while *Nike-X* will shift into high gear with $245 million in R&D funds. A total of $334 million is requested by the Army for anti-ICBM work, out of a total Army R&D request for missile work of $576.6 million.

For tactical missile defense, Army wants a souped-up *Nike-Hercules* (*ATBM*) in an anti-tactical ballistic missile configuration, using HIPAR (High-Powered Acquisition Radar). The bulk of funds requested for FY '63 were used for improvements in the system to enable better performance in an electronic countermeasure environment and to enable it to engage small high-speed bodies. FY '64 funds will be used for procurement of this improved version.

Hawk, the other major operational battlefield defense against high-speed aircraft, is funded for $67 million in the FY '64 budget.

Mobile Mid-Range Ballistic Missile, (*MMRBM*), designed to fill the range gap between the 400-mile maximum range of *Pershing* and the *Polaris A-3* range of 2500 miles, is funded in FY '63 for about $42 million, and will be pushed toward development by the next budget.

Other aspects of the Army's program include chemical-agent warheads, improved nuclear warheads, research on electronic fuzes, radar trainers and antitank weapon systems.

The Navy's *Typhon* air defense missile is having some development difficulty, and the nuclear frigate designed to carry the first *Typhon* installation has been cancelled. A full series of tests will be carried out before any production or deployment is committed.

In the overall realm of air defense for the fleet, Secretary McNamara said DOD is now re-evaluating the situation regarding the surface fleet's mission and the cost of defending it. He emphasized, however, that this is not an indication that the fleet is deteriorating in value.

"We want to avoid having the fleet exist merely to defend itself. We're re-examining the requirements for the fleet, the mix of ships and the overall effectiveness and efficiency of the fleet." ■

Changes Beginning to Pay Dividends

Incentives more widespread; value engineering emphasized; shift from sole-source buying continues to grow in scope

BROAD CHANGES in Defense procurement policies and procedures, begun in 1961 and applied decisively in the past year, are now beginning to effect noticeable changes in the long-standing pattern of DOD-industry business relations.

The general procurement and logistics directives outlined by Secretary of Defense McNamara soon after taking office, and the policy and procedural recommendations that followed from his chief procurement advisor, Assistant Secretary of Defense (Installations and Logistics) Thomas D. Morris (see page 87), have probed the business side of national defense from both the industry and the DOD viewpoints.

Seeking the best defense for the best price, DOD has looked critically into its own operation to promote new efficiencies. A parallel effort is aimed at removing industry apprehension in several areas of defense contracting, particularly the threat of government profit renegotiation.

It is still early to judge whether or not the five-year cost-reduction program outlined by McNamara will actually yield the predicted savings, but it is off to a good start. Much of the long-range economies are based, however, on increased use of contracting procedures and new buying plans that will substantially alter the methods by which major U.S. defense systems were previously procured. These projects are just getting under way. The effectiveness of the approach is still to be severely tested.

In outlining the DOD procurement and logistics cost-reduction program before the House Armed Services Committee Jan. 30, McNamara grouped all the approaches to improved cost effectiveness into three major headings: buying only what is needed, buying at the lowest sound price, and reducing operating costs. The Secretary maintains that through the programs contained in these broad headings, annual savings on defense budgets ranging from about $1.9 billion in FY '63 to $3.4 billion in FY '65 can be achieved.

Certain portions of McNamara's program will be of major importance for the missile/space industry. Most of these programs are included in the first two categories.

1) Buying only what is needed

End item requirements—Though weapons acquisition and force levels are program decisions and not part of cost reduction, McNamara asserts that initial cost computations can yield significant savings by not overstating timing problems, replacement and consumption factors, or underestimating post-development production potential. All services will continue to press studies of these requirements to reduce end-item inventory.

Requirements for parts and supplies—New military support items are flowing into the Federal supply system at the current rate of several hundred thousand items each year (average 807 items per day). The supply catalog already lists more than four million separate items. The program here will be multi-pronged: get better management of the broad supply program through the logistics agencies of the individual military services and the defense-wide Defense Supply Agency (see page 106); improve new-product screening and review requirements to cut down on needless creation of a new item for what may be a single, unrealistic specification demand; and increase the use of computers and high-speed data processing.

Use of excess inventories—By the end of FY '63, McNamara estimates, $200 million of excess stocks per year will be used in lieu of new procurement. By the end of FY '65, this rate is expected to hit $435 million. At present, its $13 billion worth of excess inventory and long-supply stocks sends shivers through DOD. DSA has been assigned central screening responsibility for excess inventory—and also for idle industrial production equipment.

Eliminating "gold-plating" from specs—This will be accomplished primarily through widespread industry and military use of "value engineering" teams. Their job: to eliminate from technical specifications unnecessary requirements on materials, quality performance, and fabricating processes. One of the beauties of value engineering is that it is perhaps the easiest of all the new programs to track in terms of its cost effectiveness.

McNamara states that during the first quarter of FY '63, savings by the services through these programs was about $17 million. The end of FY '63 is expected to bring a total $64-million saving. Goal for FY '65 is $100 million.

DOD is now setting up VE groups in contracting procedures, and incentives may be built into contracts to en-

Source Selection Revised

Present evaluation groups may be stripped of their selection functions and forced to operate only as evaluators if a currently circulated John H. Rubel memo is adopted. The selection function would go up to the service secretaries and their principal assistants . . . "consulting as appropriate with the Secretary of Defense and OSD." Evaluation Boards would have no way of knowing the relative weight assigned particular phases and would work under evaluating criteria handed down from above. The proposal is aimed only at major R&D contracts and concentrates on narrowing the field of potential bidders. Rubel says his approach would put the decision in the hands of the senior responsible people rather than having them approve or preside over decisions already made.

courage value engineering in industry.

2) Buying at the lowest sound price—Herein are the major shifts in emphasis that will alter what had become a fairly familiar pattern of doing business with DOD:

More competitive procurement—By various approaches, DOD estimates it can shift by FY '65 some $1.9 billion in procurement dollars from sole-source procurement to competitive buying. This would increase the overall percentage of competitive procurements to 39.9% of DOD buys, up 7% over FY '61.

General Accounting Office studies indicate that price reductions averaging 25% are achieved by a shift away from sole source. By the end of FY '63, McNamara reports, this should amount to about a $289-million annual saving. By FY '65, $494 million could be saved.

The services and DSA both have specific goals in competitive procurement, and a detailed monthly and quarterly reporting procedure has been set up to trace the progress.

This shift will not only lower prices but may also broaden the industrial base. There are some critics who fear it may also lower reliability, though DOD officers emphasize that the program is being approached cautiously to avoid compromising on the quality of any weapon system.

DOD will take two basic approaches, both aimed at getting components and subsystems into competitive situations sooner, but both requiring availability of extensive data packages early in the program's development to insure reliability.

DOD will attempt to "break out" high-value and high-usage spare parts and components for separate procurement instead of the automatic purchase from the primes. This requires highly detailed planning early in a program. Adequate technical data in sufficient lead time must be available to search out new suppliers.

DOD will also attempt to introduce more competition into new items as they pass from development into production, or as soon as possible once in production. If this is successful, McNamara reports, "we can avoid the price premium usually associated with the first large-scale production buy under sole-source procurement."

Contracting shifts—The most far-reaching and probably most difficult new DOD procurement objective to achieve will be the extreme shift away from cost-plus-fixed-fee contracts to far more fixed-price and cost-plus-incentive-fee awards. The ability to achieve this long-sought goal will create significant dollar gains. But—perhaps more importantly—it will also promote vast new efficiencies in evaluating and cost-estimating new weapons systems.

McNamara recently told Congressmen that "because CPFF contracts do not distinguish between good and bad planning, early or late completion, and tight or loose financial controls, they lead to the kinds of cost overruns which have resulted in some programs costing between three and 10 times the amount originally estimated and budgeted. This situation has often led to decisions to produce and deploy weapons systems where a contrary decision might have been made if the true costs had been known."

The DOD goal, admittedly a tough one, is to reduce CPFF contracts to 12.3% of total procurement by 1965. This will require an estimated $6-billion shift to fixed price and CPIF awards. The trend toward use of CPFF has been building steadily in the past decade but has been altered significantly since the last quarter of 1961. From a peak of 38% of total prime contracts during the first nine months of '61, it had been reduced to 32.5% by the end of FY '62.

Shifting to different types of contracts is one area in which it is difficult to measure cost savings accurately. So far, the estimated reduction in final costs is judged by DOD officials to be at least 10%. Progress to date, they report, is estimated to have saved $115 million. By the end of FY '65, McNamara hopes to have upped this annual saving to about $639 million.

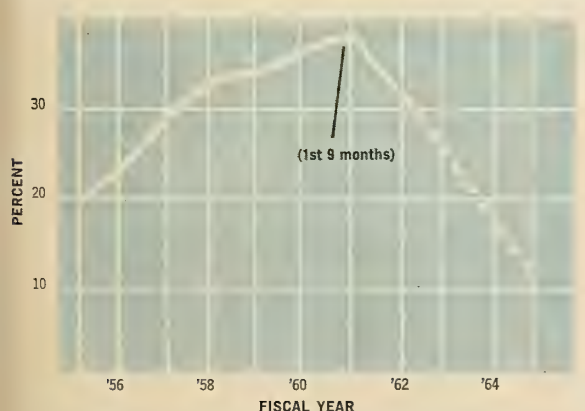
- **Incentive use**—DOD officers point out that incentives, though generally tied to some aspect of cost, will shift throughout the development and production progress of a weapon system. Pure cost incentives will be used primarily in the latter production phases. In earlier development and prototype work, the major incentives are likely to be based on such management functions as improved technical performance, scheduling of work and delivery time.

Weapon-system hardware research and development is the prime area where DOD is anxious to use CPIF. This is evidenced in the extensive new revisions to the Armed Services Procurement Regulations (ASPR), where, one DOD procurement official says "we're making it tougher than nails for the services to use CPFF. About 200 changes were made to ASPR last year alone, many in the contracts section. DOD reports an additional backlog of about 70 changes."

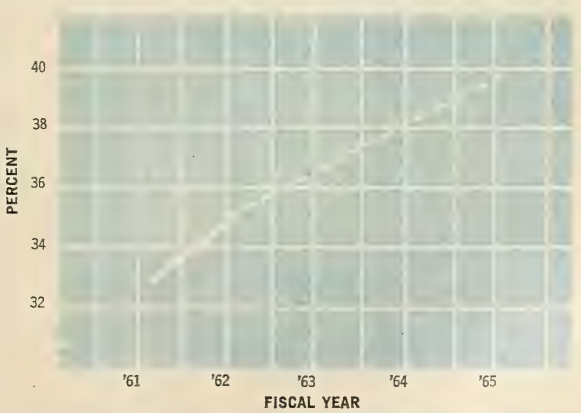
Eventually, DOD hopes to move strongly towards use of fixed-price contracts as perhaps the ultimate in cost effectiveness. Fixed-price contracts in major development programs will require long experience and complete familiarity on the part of both DOD and industry with cost and responsibility details of the project.

3) **Reducing operation costs**—This portion of the five-year program is not of too much direct concern to missile/space firms, except that it also contributes to overall DOD efficiency and economy, which may indirectly allow fiscal support of hardware programs.

This aspect of the program is aimed at terminating unnecessary operations by closing or reducing bases and instal-



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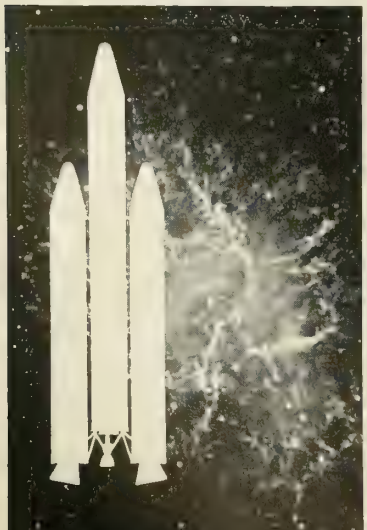
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lations, standardizing and simplifying paper work and procedures (included here are two very important innovations —MILSTRIP and MILSTAMP—intended to introduce uniform service-wide requisition and material movement procedures), and consolidating and increasing efficiencies of operations. Savings attributed to the newly created Defense Supply Agency are included in the effort to reduce operating costs.

• **Other contract trends**—Other important shifts in contracting methods are going to affect the missile/space industry. Among these is increased use of Program-Definition-Phase contracts as the initial approach to new and large system developments.

PDP, as it is described, should add up to significant savings for both DOD and industry. Though critics maintain it may stretch out programs to a point dangerously close to minimum operational readiness time, McNamara is convinced that "we must do our thinking and planning before we start bending metal. By a more complete study . . . of all facets . . . prior to major commitments—we can reduce the number of expensive projects which might otherwise later have to be reoriented, stretched out, or terminated."

McNamara points out, however, that PDP contracts will be used primarily only with developments which, if successful, would add only marginally to combat strength. For developments in which there are possibilities of "great potential pay-off, correspondingly greater costs and risks are justified . . . . We believe," the Secretary adds, "that the substantial increase in the defense program initiated in the last two years has put us in a position where we can now afford to move more carefully in the initiation of new major weapon system developments."

DOD officials say there will be significant savings for industry in project proposal costs, an area that has recently drawn attention as one in which costs are becoming especially severe. Though DOD is currently making it clear that "frills" on proposals, such as hardware models, won't help the submitting firm, it feels strongly that increased use of PDP will significantly slice proposal expense.

• **Geographic considerations**—DOD admits that geographical considerations influence award of DOD contracts, but says that these are always qualified. DOD must go where the best R&D capability lies, regardless of labor surplus. Only if two firms roughly equal in technical competence bid on an R&D contract and one is in a labor surplus area, the contract would probably go to the needy area.

But DOD officials emphasize that in all procurement, no government premium will be paid for aiding depressed areas. Prices must be competitive. Wherever possible with large production procurements, DOD officers report, the procurement may be split—with all firms bidding on one-half the buy, with the other half reserved, or "set aside," for labor surplus area firms to bid on, again provided no premium is paid for diverting the work to these areas.

• **New industry moves**—Since the 1961 reorganization at the Defense Dept. and the advent of the newly outlined procurement objectives, DOD has moved ahead with several internal programs to improve its ability to get the job done. It has also sought a more intimate understanding and relationship with industry.

These moves by DOD, both inside and out, have generally met with favorable industry response. "The drive to make the defense business more competitive," asserts one DOD officer, "has generally made doing business with the government more closely related to commercial business endeavors."

Of particular importance to industry is the current "vigorous action" being taken by DOD to bring the government's Renegotiation Board in on the step-by-step development of new DOD contractual procedures based on incentive procedures.

Closer relationships between DOD and the Board are expected to remove much of the threat to industry of having profits renegotiated after completion of a contract in which there may be confusion concerning contractual requirements, contractor costs, and performance.

The new DOD-NASA contractor evaluation program (M/R, Feb. 11, p. 14) expected to go into operation this spring is also intended to make it easier for the Board to act in certain cases with details plainly at hand.

• **Contractor rating**—The new system is currently under study by a group in the office of Department of Defense Research & Engineering. Essentially, the rating system will provide, on a need-to-know basis, a central DOD file on how a contractor does his job with respect to his cost estimates, his ability to meet the agreed-upon time schedules, and the technical performance of his product. NASA will have a parallel program with coordinated data.

The data presumably will be collected by newly created contractor evaluation offices spread around the country and operated by the armed services and NASA. It will then be made centrally located within the OSD.

Initially, DOD officers stress, the system will document and evaluate contractor performance on the engineering and operational development phases of



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*This classic phrase was struck by President John F. Kennedy February 20, 1962, in his remarks over television welcoming Astronaut John H. Glenn, Jr., back to Earth.

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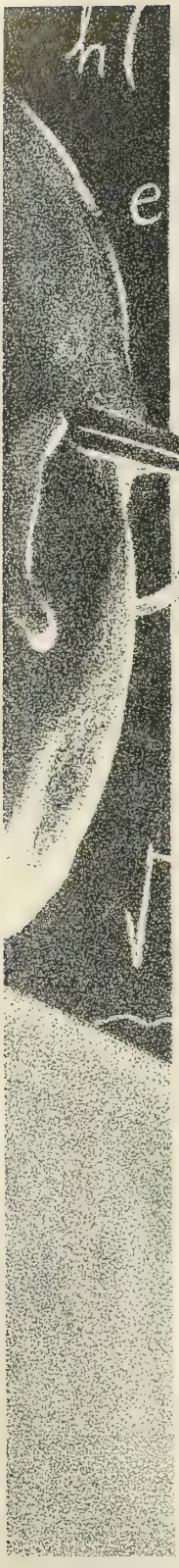
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medium- and large-scale test-type programs.

There is expected to be a dollar-value limitation to the contracts on which DOD and NASA will evaluate performance. For DOD, a $20-million minimum contract value has been mentioned, but is not yet firm.

Contractor-evalutation schemes now exist within DOD and the armed services, but the exchange of information and uniformity in evaluation are viewed by many observers as only marginal.

Though some contractors tend to view the new DOD evaluation project as a potential "blacklist," it should not be confused with the "debarred" list now used by DOD. A contractor can put himself on the latter list very quickly, primarily for fraudulent behavior or non-compliance with Federal fair employment practice laws.

A company can also be placed on the "debarred" list through failure to meet specs or delivery dates.

● **DOD-industry meetings**—Sec. McNamara's reign at DOD has been characterized by a continuing round of relatively frank DOD-sponsored meetings throughout the country, where defense and industry representatives have produced exchanges which served to further understanding on both sides.

Also in this realm is the establishment last summer of the Defense Industry Advisory Council, which provides the offices of Secretary McNamara and his staff with regular, direct inputs from industry.

Deputy Secretary Roswell Gilpatric, who created DIAC, is generally recognized within both DOD and industry as the man who personally created much of the improved atmosphere for communication between the producers and the heretofore less frank users.

Also, DOD is taking another look at the extent of its small business procurement policies. McNamara initially asked DOD procurement personnel to raise the small business share of DOD dollars by 10%. This was accomplished last year. However, DOD officers report that small business participation in DOD programs becomes increasingly difficult to measure and needs more refined tracking methods.

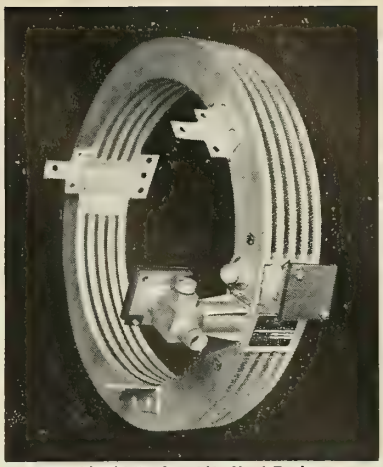
One DOD official told MISSILES AND ROCKETS that there are, basically, no ground rules for small business participation. Oddly enough, once a small business gets a good chunk of DOD dollars it is no longer small—and this snarls the calculations. Furthermore, stepping up the flow of dollars to small business is no real guarantee that its percentage of participation will go up: the total DOD budget is likely to expand, making a broader base on which to figure percentages. ■



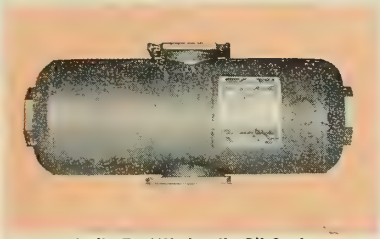
IRBM Guidance Cooler, FC-75/Air



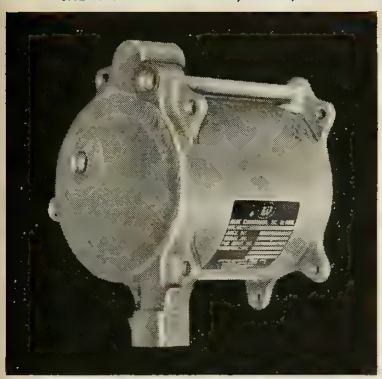
Missile GSE, Freon/FC-75 Evaporator



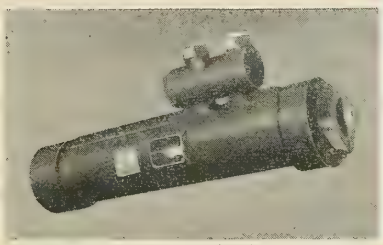
Space Liquid Engine, LH_2 Heat Exchanger



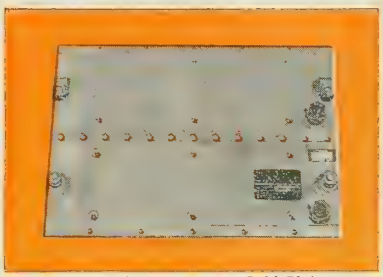
Missile Fuel/Hydraulic Oil Cooler



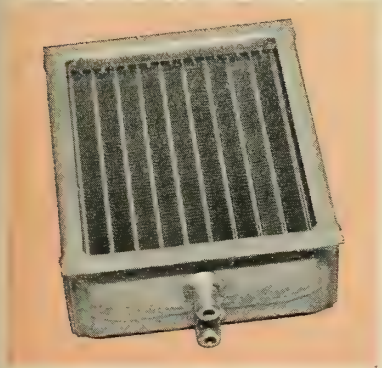
Manned Spacecraft, APU Lube Cooler



ICBM RP-1/Hydraulic Oil Cooler



ICBM Guidance System Cold Plate



Missile Guidance Cooler, FC-75/Air



Missile Engine Lube Oil Cooler

THE HEAT'S OFF

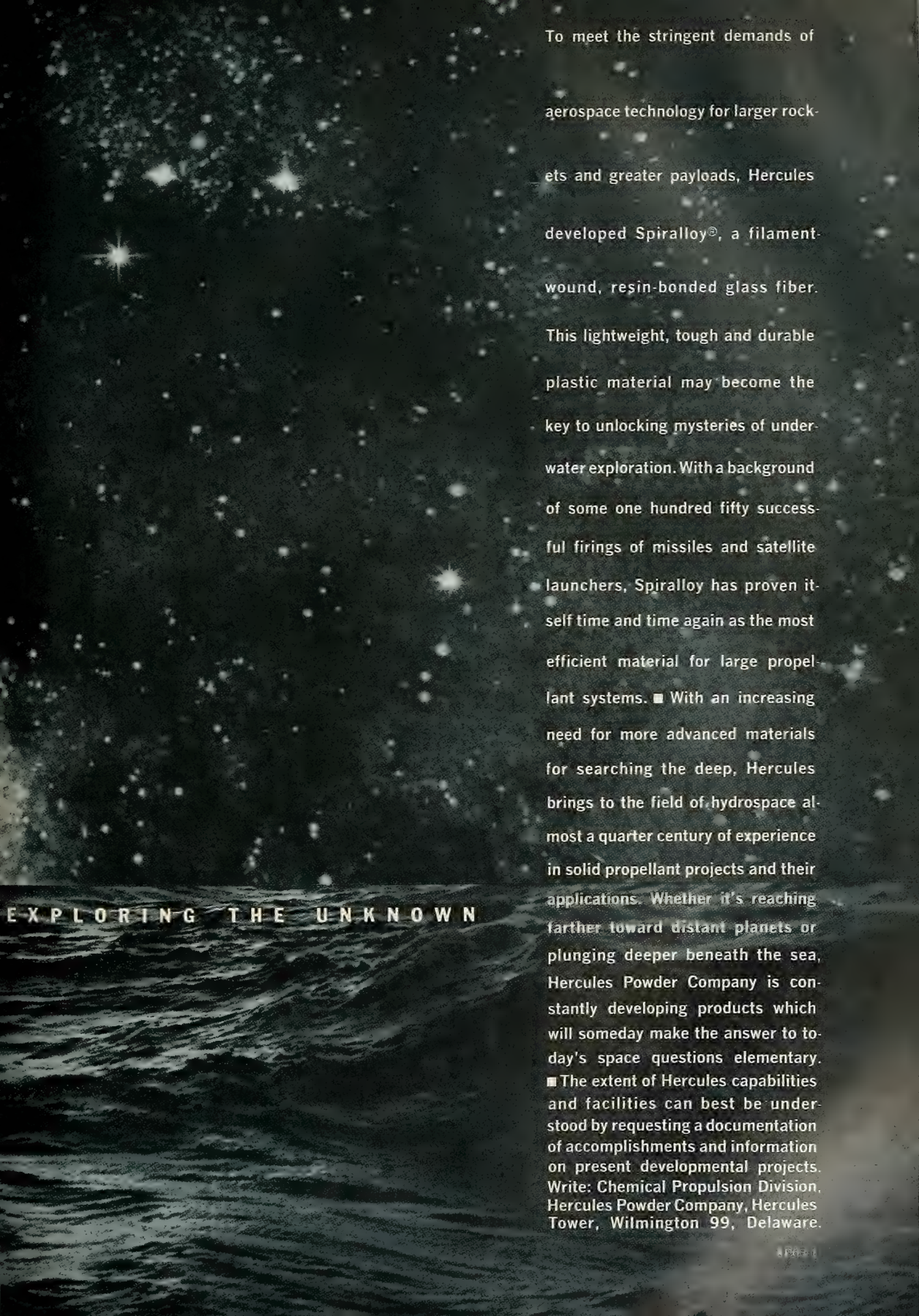
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Brown and his staff instill new comprehension of cost factors; how $7.37 billion in funds will be managed

"We are not interested in supporting the intellectually challenging, but militarily useless, engineering 'tour de force'." —Secretary McNamara

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The director is specifically charged with supervision of all research and engineering activities within the DOD. But within the wording of the 1958 act lies a power delegated to the Secretary that can change the supervisory function of DDR&E to active direction.

This is a latent power, and neither of the two men involved in running DDR&E to date have sought to invoke it. Instead, Dr. Harold Brown, second and current director, has continued to maintain supervision through technical expertise and fiscal control.

This will probably be the case until the next Reorganization Act is signed.

● **Policy level**—In his testimony before Congress on the Fiscal 1964 budget, Brown named as one of his biggest problems the fact that too many decisions have to come all the way to the top. In effect, the highly respected DDR&E chief wants to push decisions back down into the services—not only on the many minor or less controversial programs, but also those involving the huge expenditures.

"But," says Brown, "making decisions means making choices, and if the choices are not made further down in the system then they have to be made by the Secretary of Defense on my advice and the advice of others."

Brown admits there are some things which the Director of Defense Research and Engineering and his staff have to handle. These are the programs that are controversial, the programs generating Congressional interest, the programs involving a lot of money, and the programs having a big effect on our military posture.

But even these should involve a great many more service decisions, he says.

Brown has nothing to do with proposals and contractor selection, but he has a great deal to say concerning the existence of a program in the first place. His area is limited to technical considerations—but here he will not take a back seat to anyone.

One service spokesman, heavily engaged in the R&D battle with DDR&E, frankly admits that the DOD research chief and his staff have considerably sharpened the technical thinking within his service.

This has been achieved by the constant, frequent and penetrating reviews into that service's R&D programs conducted almost as a matter of course by Brown and his staff.

Another DOD-level manager credits Brown, the scientist, with an unparalleled insight into the business and financial aspects of the complex weaponry now moving through the Pentagon.

His seemingly constant preoccupation with cost figures, so much under public attack both in and out of the Pentagon, merely reflects reality—there is only so much money and a great many intelligently conceived and technically sound programs are clamoring for it.

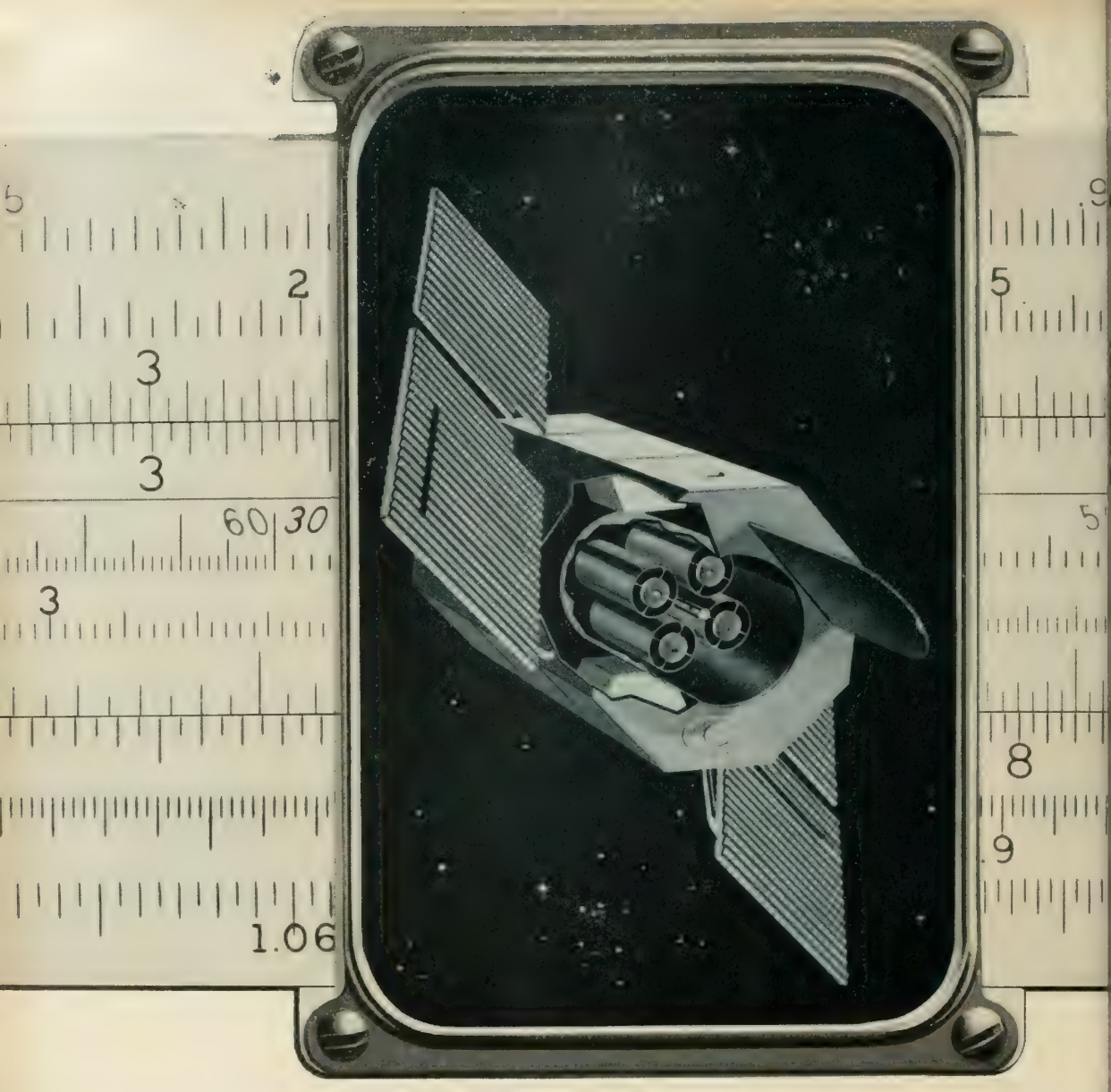
Much confusion exists concerning the nature of Brown's advice to the Secretary of Defense. Actually, his inputs are technical, shorn of military aspects. And they are reached through a fairly straightforward method—consultation with acknowledged experts, study analyses, and a complete understanding of the particular question involved.

● **Example: Skybolt**—Brown and his staff evaluated the *Skybolt* from the standpoint of its R&D program. In his words . . . "that is, how long I thought it would take to complete the development, what I thought the reliability would be, and how much I thought it would cost to achieve this reliability."

His conclusions were that *Skybolt* could be made to work—but at a cost well over the programmed $492 million—and that it had already slipped from three to six months beyond the previously estimated completion time. In addition, while its reliability might increase, Brown determined, it might

(Continued on page 45)

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EMR electro-optics make space

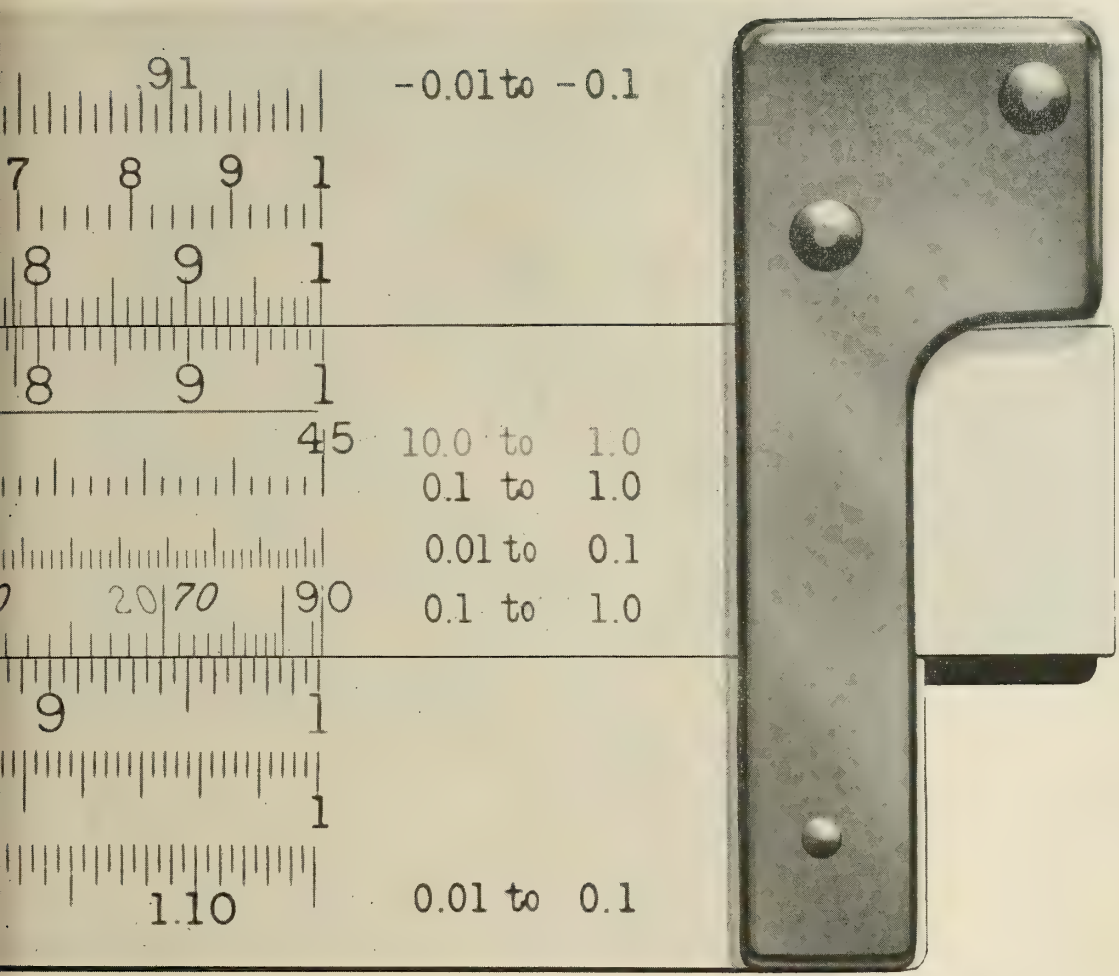
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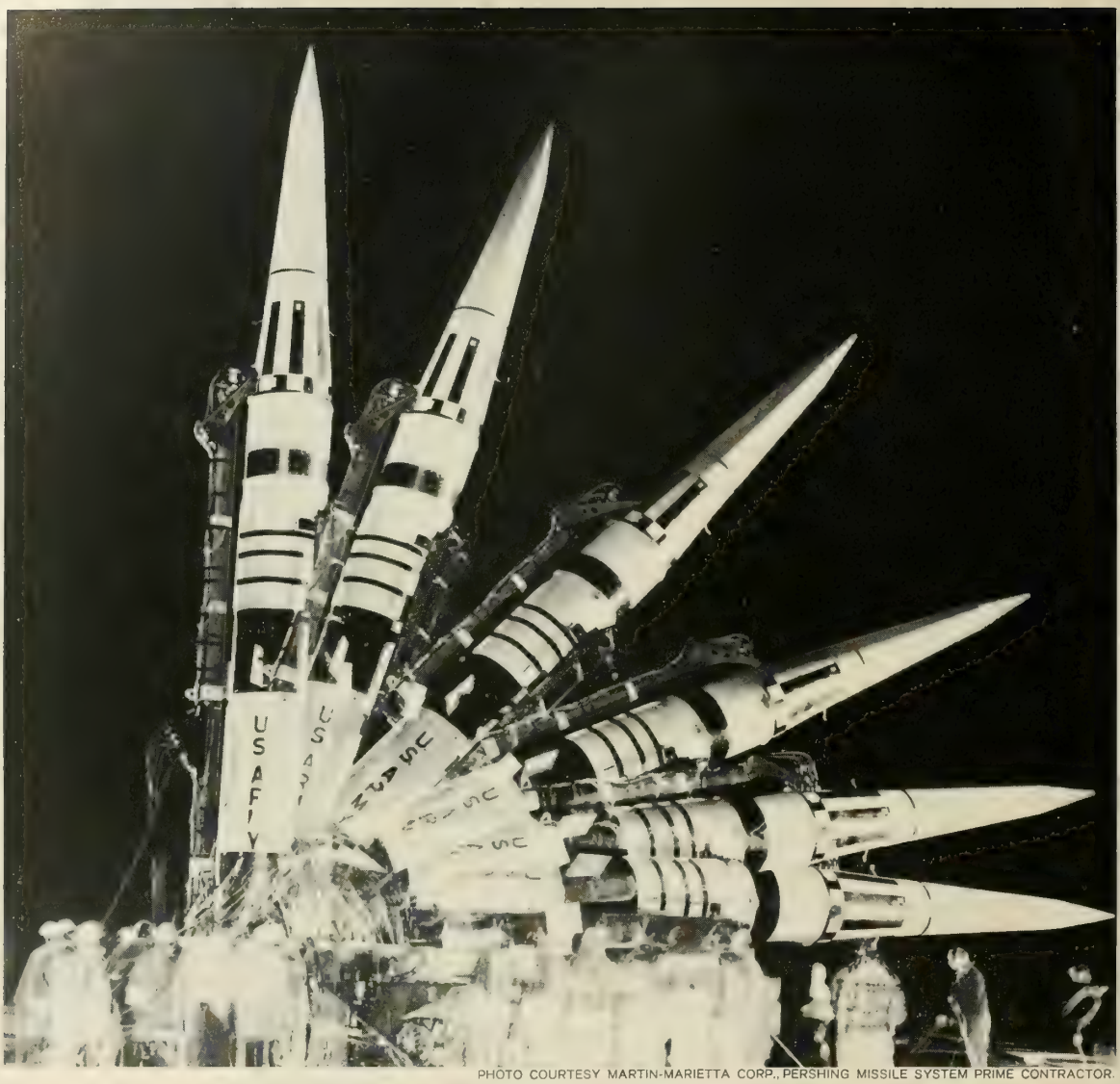


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(Continued from page 41)

never reach an acceptable percentage even after five or six years of operation.

The upshot of Brown's technical analysis of *Skybolt* was a recommendation to McNamara that the system probably should be cancelled from a technical point of view. Brown did not make any overall judgment as to whether *Skybolt* was better or worse than something else. His advice covered only that area requested by McNamara, who had to make the final decision.

● **Example: Nike-Zeus**—Brown also evaluated the *Nike-Zeus* from a technical standpoint. His thoughts were expressed to Congress as follows:

"As an R&D program it is a very fine program. That is to say it is a case where the contractors and the service, the Army, have come quite close to meeting their time goals. I think they have slipped only a few months in a five-year program. The costs have been what they said they would be."

Although Brown pointed out that the program has another year to go, he estimated that it will be able to do what it was designed for with a high degree of effectiveness—intercept a single incoming object.

But, if faced with a more advanced threat,—consisting of many missiles—Brown felt that *Zeus* would have a rather low effectiveness. Again, the conclusion reached by Brown and his staff was based on technical considerations—the threat posed and the design purposes of the system.

● **On doing business**—R&D contracting is handled differently from normal DOD procurement and the trend under Brown is toward more cost-plus-incentive-fee contracts.

The services handle by far the bulk of this contracting and its main point of departure from ordinary procurement is that the bidders are determined from a list. This list is made up by the service in most cases.

When the service has a program of some sort in development, a number of bidders will be invited to participate. The service's choice of these bidders is based on their past experience and performance in the field.

Occasionally a firm will be removed from this list if it is in some particular trouble—such as difficulty in meeting the demands of some past contract. When this condition is removed, the firm will again be placed on the list.

The prime tool in handling cost-plus-incentive-fee contractual situations is the program definition technique (see box). In the program definition phase, both parties agree beforehand as to what is expected in performance and cost levels. Any divergence from these agreed levels will result in a lower or higher fee—or no fee at all.

A case in point is the *MMRBM*—currently going through this phase. The missile is now in program definition and the Air Force has named contractors to handle the various parts—launcher, missile development, guidance, integration and checkout, and re-entry body.

These contractors are engaged in a government-funded program-definition phase which will run through next month. After that, Brown says, statements will be made regarding what the system can do in the way of range, CEP, payload, reaction time and other criteria. Various kinds of deployment are also under study here—shipboard, land, adaptation for quick transport rather than mobility, etc.

On the basis of these Air Force funded studies, the Secretary of Defense will decide whether to continue with the *MMRBM* program. Brown expects this decision to be made this summer, and he has indicated that there is a fair chance of the program moving into full-scale development.

The Pentagon research expert qualifies this by noting that the choice is not in his hands. It will be made by the Secretary, based on a total picture—not just the technical status of the *MMRBM* in relation to its design purposes.

● **Staff functions**—Brown uses his staff in drawing up answers to specific technical queries from McNamara, answers based on their individual experience and expert fields. Since Brown's recommendations are in the nature of technical judgments, he relies on people—military or civilian—with recent experience along the particular lines.

For instance, if the point in question is an uncertainty of the landing error of a ballistic missile, Brown requests information from someone on his staff recently involved with the development of missiles. If it is a payload question, the input is from someone with experience in this area.

Thus the purely military element is separated in the decision process by considering only the technical aspect. Brown says the question of whether the CEP of a certain missile will be 600 ft. or 2000 ft. is not a military or a civilian question. It is a question of fact, he says, of technical judgment, of development judgment. Brown does not consider military requirements because they are not part of his function.

The exercise of supervision works through the review process. This is constantly going on in any number of given program element areas for any number of reasons. There are what Brown calls "natural" review initiation points—budget, appropriations, program shifts from one development phase to another, and the defining of new military requirements.

Some reviews are more involved than others. For instance, those initiated for budget planning reasons are far more detailed at certain points in the progress of a program—especially if a major financial decision is near.

The review system, especially in

A Definition of Program Definition

PROGRAM DEFINITION is simply the process whereby, with reasonable precision, a proposed weapon system is defined as regards its performance, schedule, and cost.

The program definition phase precedes full development (i.e., after Advanced Development) in order that development decisions and contracts may be based on knowledge of what the true capabilities of the weapon system, and the actual costs, and time of development, are likely to be.

It is generally acknowledged that one of the primary causes of overruns on weapon system development programs is that contract cost estimates are prepared by contractors independently, in too short a time, and are based on an inadequate understanding of an incompletely defined program.

Perhaps the most important feature of the program definition phase procedure is that contractors who will do the full-scale development job, if it is done, are funded to work with the buying agency (i.e., one of the military departments) and with one another to define critical interfaces and to settle upon the most promising approaches to the solution of mutual problems. From the resultant understanding of the real job to be done emerge greatly improved schedule and cost estimates.

In addition, management arrangements are studied and made ready for use during the development phase, the full-scale development phase.

On the basis of work during the program definition phase an informed decision can be made on whether or not to proceed with the development, and on precisely what program should be pursued.

—Dr. Harold Brown
before House Armed Services Committee Feb. 5, 1963

budget and appropriations, is the prime method used to eliminate unnecessary duplication. Brown is extremely careful to point out that this means technical duplication, not military requirements, though the same specific projects may come under fire.

For example, Brown says that, during the budget process, he reviews each program element in detail. This may mean going into a specific project, or a specific task within the project, and comparing it with other programs in existence in other services.

Sometimes the services themselves are asked to make comparisons of their own efforts and those of other services, in projects aimed at a specific end.

The whole question of duplication in research is closely related to the concept of research. Programs may be initiated and then dropped during some subsequent review for a number of reasons—and Brown admits incorrect initial judgment is sometimes a factor. But circumstances also change, in which case a decision to continue may be correct at one point in time and a decision to suspend may be equally correct at another, subsequent point in time.

Brown thinks it is important to start more projects than are finished in research and development. This procedure provides more information leading to a choice of which programs to drop —information lacking at the initiation of any given project.

● **Management basis**—The total RDT&E program is built up from the smallest identifiable unit of work—the research or developmental task. This unit represents a specific work assignment at a laboratory or an identifiable item for which a grant or a contract may be let.

Brown defines these tasks more fully by saying that each is directed to the accomplishment of projects which describe, in a more meaningful form, a discrete entity of R&D effort directed toward some end product.

The current program structure involves some 20,000 identifiable pieces of work.

RDT&E projects are grouped into management units called Program Elements. This grouping reflects the overall DOD management structure and provides visibility into the complex R&D area from the positions of the various military departments and the Office of the Secretary of Defense (OSD).

The Program Element is a line item in the Five-Year Force Structure and Financial Program and is the focus of the detailed reviews so much a part of the current DOD operation.

For Fiscal 1964, the RDT&E program is described in 325 Program Elements covering the thousands of research tasks involved in providing a technical base for improved or new weapons systems.

These Program Elements are identical with the budget sub-activities presented to Congress as justification for the RDT&E appropriation request. Brown's example of this is the Navy's *Typhon* missile—it is a program element under the category of Engineering Development in the DDR&E program structure and also a budget sub-activity under the category of Missiles and Related Equipment under the Navy RDT&E appropriation title.

This means that each Program-Budget sub-activity is planned, reviewed in DOD and presented to Congress on the same basis. Following the authorization, appropriation and apportionment of funds, the Program Element-Budget sub-activity then enters the program execution phase involving the obligation and subsequent expenditure of funds.

Management emphasis is applied to the various types of effort within the RDT&E program structure by a categorical division into Research, Exploratory Development, Advanced Development, Engineering Development, Operational Systems Deployment and Management and Support.

In addition to the Program Element process, these categories lead to an understanding of the control exercised by DDR&E in balancing the effort between developing technology and the actual engineering of hardware.

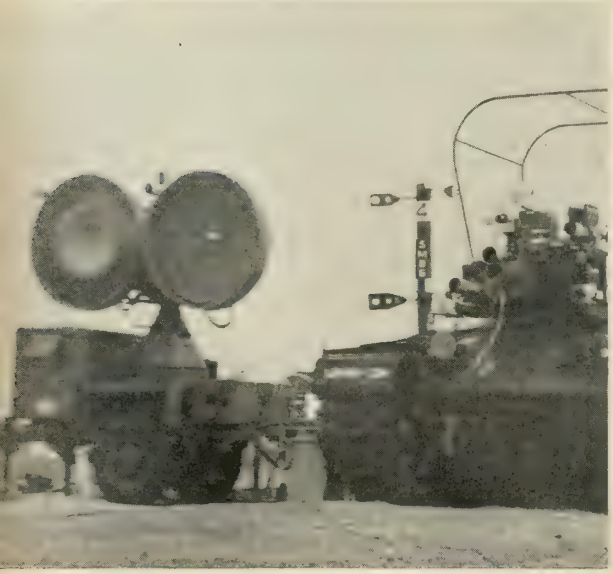
The Program Element system keys into the DOD budget format and reveals the financial support required in a manner amenable to cost reviews. The categories define the movement of programs from conception to deployment and allow the flexibility needed to support the basic technology underlying all future weapons systems.

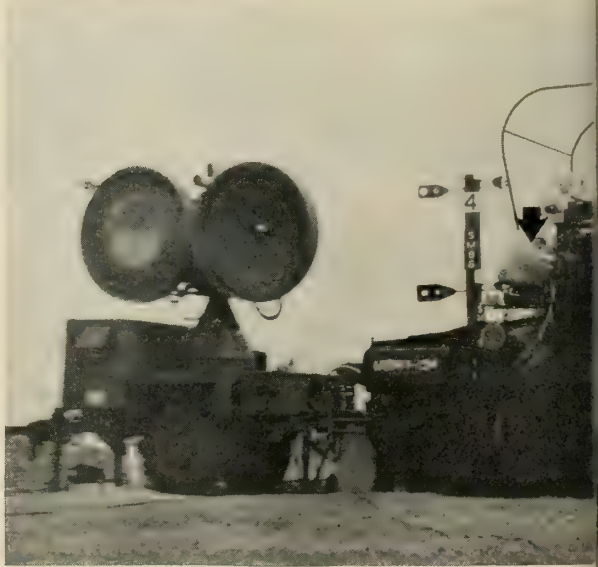
One theme remains a constant in every aspect of DDR&E. The end product must be superior equipment for the Armed Forces—yet there must be an equal and concurrent alertness against premature initiation of hardware development.

In a nutshell, hardware development programs must be soundly reinforced by existant technology.

Shillelagh Test Launching Pictured

FIRST FIRING photographs of Army's surface-to-surface tank-mounted Shillelagh missile, under development by the Aero-





This is the ideal. It is obvious to DDR&E spokesmen—as well as to the various R&D operations within the services—that it is approached by degree. Thus the management of DDR&E is designed to implement this theme and the current organization is believed to be the optimum arrangement for the planning, programming, budgeting and execution of each element in the total program by those now charged with the management of DOD.

● **Breakdown**—In Fiscal 1964, the DDR&E total obligational authority is $7.37 billion. In a breakdown by categories, the Research area will use some $362 million in fiscal '64 covering basic and applied research in the physical and environmental sciences, mathematics, psychology, sociology, biology and the medical sciences as well as independent in-house laboratory research.

Each of the three military departments will receive increased funds in this area while ARPA's research effort will remain stable.

This category has a connotation peculiar to DOD. In the classical sense, the programs funded here are both "basic" and "applied," but DOD terms it "basic" research in the sense that there is no direct relationship whatsoever to any known military requirement.

The next category, Exploratory Development, is programmed for $1.17 billion and covers efforts aimed at the solution of military problems. This area may range from investigations into physical phenomena with some application in mind, through studies, to the development of minor components and possibly some bread-board hardware.

The end product here is the determination of the feasibility of concepts and the understanding of engineering characteristics to the extent necessary to support an intelligent decision to proceed into hardware development.

In the DOD picture, this exploratory area is not directly related to potential military requirements. It represents an advancement of technology with the belief that it may subsequently benefit the military forces.

The Army effort will use $217 million for such things as applied research in rocket propellants, mine warfare, improved designs for armor-defeating projectiles and surface mobility.

Exploratory development in the Navy calls for the expenditure of $368 million in ASW areas, navigation, weaponry, ship and aircraft construction, among other things.

About a third of the $330 million slated for the Air Force in this area will be devoted to space or space-related subjects. These include experimentation in the broad fields of guidance, flight control, life sciences, surveillance and electronics techniques.

The remaining $256 million goes to ARPA for exploratory development projects.

Taken together, the two categories represent an expenditure of more than $1.5 billion that is not specifically related to weapons systems, and a considerable portion completely free of known or anticipated military needs.

The first hardware projects clearly identified and managed with respect to their contribution to military technology appear in the Advanced Development category.

About $728 million or 10% of the total RDT&E effort for Fiscal '64 will be spent in Advanced Development. This area covers projects which have advanced to the point of requiring development of experimental hardware for technical or operational testing, but have not reached the stage in which it is determined whether the items should be designed or engineered for eventual service use.

The category includes the *X-15*, communications satellites and associated support, *Dyna-Soar*, the *Aerospace Plane* and the large solid booster program, among the space-related projects.

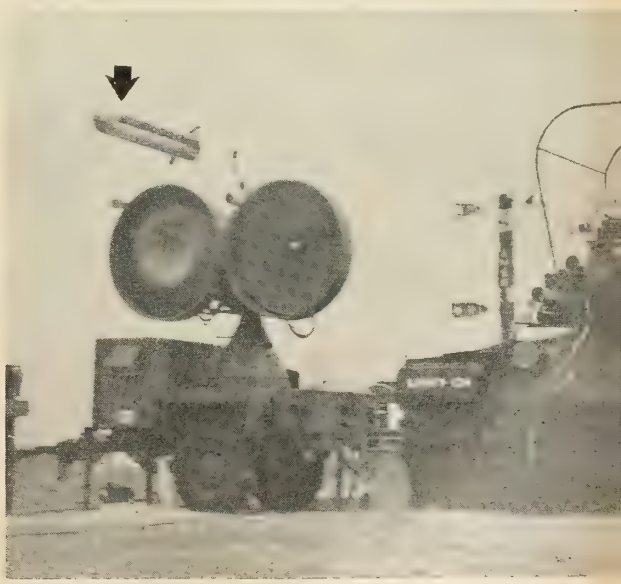
There is also funding here for the Advanced ICBM Project—this is not a development program, but rather a project to investigate technological and operational concepts for ballistic missiles.

The next two categories are identical in terms of the RDT&E work performed—with one major difference. Those programs delegated to Engineering Development are not approved for production and deployment. Once this approval is granted, the program becomes a part of the Operational Systems Development category within the DDR&E management concept.

The Engineering Development category covers all of the controversial programs—B-70, *Nike-Zeus*, *Nike-X*, *Missile B* or *Lance*, *Typhon*, and *Dyna-Soar*. The *Shillelagh* will move out of the Advanced Development category and into Engineering Development in Fiscal 1964. The funding here provides

nautic Division of Ford Motor Co., in recent test at White Sands Missile Range, N.M. The system will move out of DDR&E's Advanced Development category and into the Engineering Development in 1964, under funding for Fiscal '64.





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The total planned obligational authority for both Engineering and Operational Systems development is $3.887 billion—almost 53% of the entire RDT&E program.

The last category in the DDR&E structure—Management and Support—provides for the operation of installations such as the three missile ranges, test facilities and laboratories, together with specialized technical and scientific services performed under contracts with outside institutions.

This category will be funded at the $1.072-billion level.

Brown's rationale of the balance between technical development and the production of hardware results in a two-to-one ratio—for every two dollars going into weapons development there is a current expenditure of one dollar for progress in the technology leading to future weapons systems.

Brown arrives at this general ratio by considering both the Research and Management and Support categories as technical and operational "overhead," since both are necessary to the conduct of viable RDT&E programs but are not clearly identifiable in their contribution toward the development of specific weapons and equipment.

For the purposes of his analysis they are excluded from the balance between technology and hardware. Brown says that technology is advanced toward the solution of military equipment problems by Exploratory and Advanced Development effort.

Grouping these two together under the technology heading, the cost runs roughly to $2 billion—compared to the $4 billion of hardware engineering this technological effort supports.

The balance is a result of past experience and a careful evaluation of the requirements in each category as expressed by the military departments. DDR&E spokesmen believe it represents a correct balance at this time, but the cost of developing technology in tune with the hardware effort may continue to rise in future years.

The set-up of the Five Year Force Structure and Financial Program permits a clear expression of need and ideas by the services, and each of the currently funded programs was reviewed personally by Brown as well as by his staff.

● **Only so much**—But the program is only a management tool. The availability of competent technical manpower forces competition between programs in the research and development area. In developing the Fiscal '64 program as reflected in the budget requests, Brown and his staff considered program requests and suggestions totalling over $10 billion.

Technical considerations have a dominant effect on the R&D program in the Research, Exploratory Development and Advanced Development categories.

In the areas of hardware development, says Brown, where the effort has such a marked effect on total forces and requirements, the other staff components of both OSD and the military departments have very important inputs to make to such programs.

These major hardware decisions are reviewed in great detail, says Brown, by the Secretary himself after consultation with his military advisors, the Joint Chiefs and his civilian staff including the service secretaries involved.

The very nature of RDT&E demands flexibility in management and the review and balancing of effort among the programs is a continuing process. This flexibility is evident in the funding legislation submitted by DOD and it is based on the same principles and cast in the same form as the fund authorization legislation for the procurement of aircraft, missiles and ships.

This form provides the ability to effect program changes requiring the reprogramming of funds in the RDT&E area—a necessity if the response to swiftly changing requirements generated from technological developments is to be adequate.

One of Brown's major functions is the active direction and control of research and engineering activities the Secretary considers to need centralized management. This authority is exercised through the Advanced Research Projects Agency (see page 80).

Brown does not consider ARPA as part of his immediate office, but it is completely under his control as Director of Defense Research and Engineering. The other group nominally associated with DDR&E is the Weapons Systems Evaluation Group. This latter is not directly under Brown's control. He functions as its administrative chief. WSEG (see page 80) does not evaluate contractor proposals. It does handle technology and requirements and the interface between the two. It also may evaluate the capability of existing systems.

Brown does not determine WSEG studies except for those he specifically requests. He does not select WSEG personnel. His function is administrative. Very little operations analysis goes on within DDR&E outside of that performed by WSEG.

● **Domestic problem**—One of the major headaches associated with running DDR&E is the administration of the DOD in-house laboratories. There are about 80 major and a number of smaller laboratories operated by civil service and uniformed personnel—totalling over 30,000 scientific and technical people.

In financial terms these installations' programs and support facilities involve some $1.6 billion—a significant investment of resources, says Brown.

These laboratories have always proved more difficult to administer than the other, more customary, military installations in DOD. Formalized rules, however essential to a large organization, often unintentionally hamper attempts at creative research, says Brown.

All of the scientific administrators faced with this problem have agreed to the basic proposition that the rules of operation should be adapted to the requirements of the particular laboratory rather than the reverse.

Brown says the essence of the difficulty in administration here is that the proposition has not been fully followed in practice. One problem is the peculiar nature of a government laboratory—it is called on to do things not normally associated with the function of its civilian cousin. This is in relation to monitoring contracts with industry, manning source-selection boards, reviewing given technical areas and briefing higher management or training contractor personnel.

On the plus side, Secretary McNamara has instituted a program of "unfettered" funds—currently totalling over $30 million—to be used by the laboratory directors as they see fit in supporting research ideas.

It is also now a policy that significant and challenging work be assigned to the laboratories. Brown and his staff have been active in implementing these directives in an effort to stem the in-house erosion of competent personnel.

The main effect of this is a noticeable rise in morale and a greater initiative at the working-scientist level. The main purpose is to keep a competent level of technical ability within government to ride herd on the contracted technical work in industry.

● **Space spending**—On the question of military involvement in space, Brown says almost $1.6 billion of the total Fiscal '64 RDT&E budget request concerns space. The space sector of the Air Force's RDT&E budget is about 40% of the total and, according to Brown, a third to a half is for fairly specific military applications which can be identified.

The rest of the money—at least half, says Brown—is for developing capabilities which may be needed in the future but which cannot be proved as needs right now.

Brown feels there is a close relationship between DOD R&D and NASA at all levels. He himself is a co-chairman of the DOD/NASA Aeronautics and Astronautics Coordinating Board, along with Dr. Robert C. Seamans, Associate Administrator of NASA. ■

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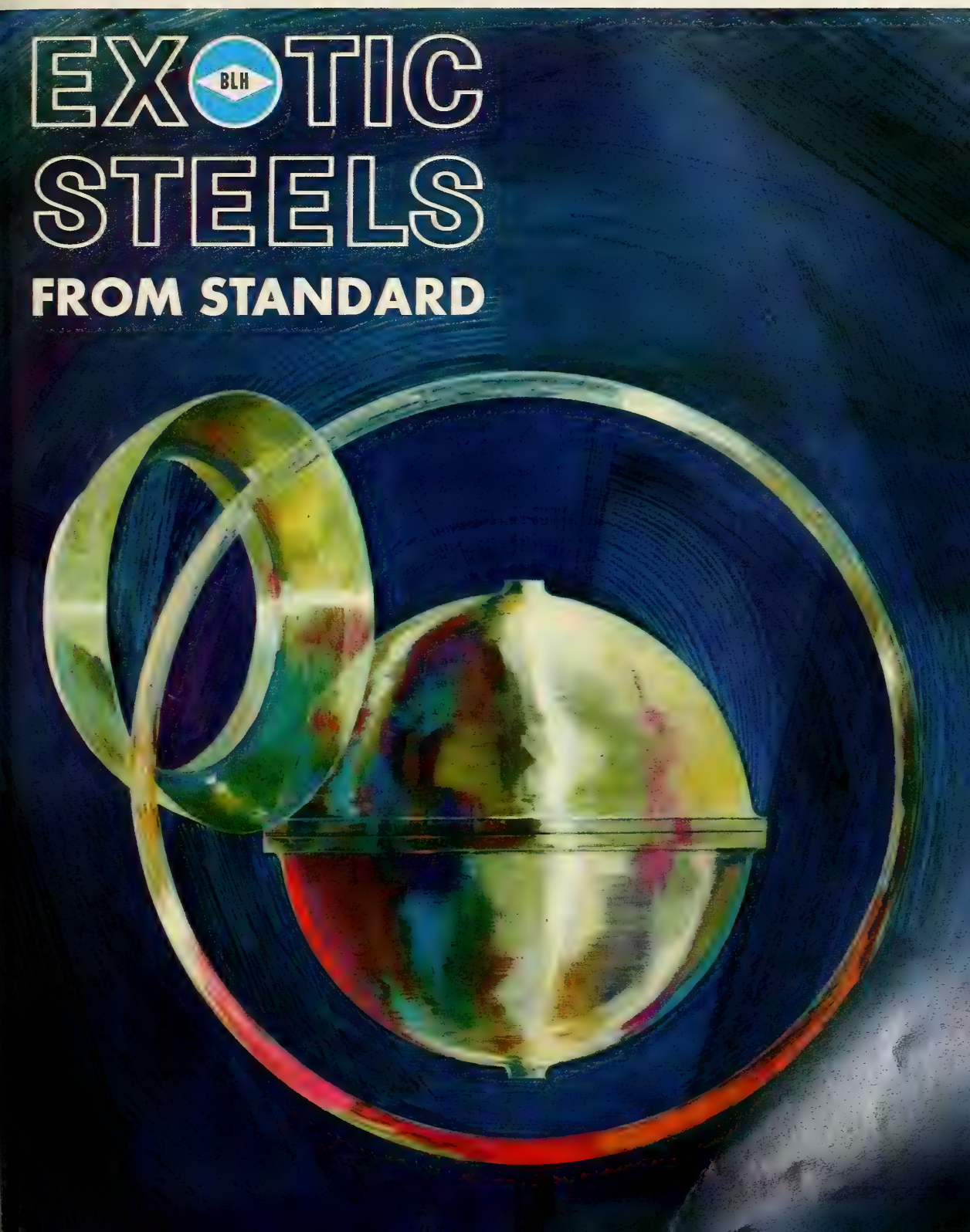
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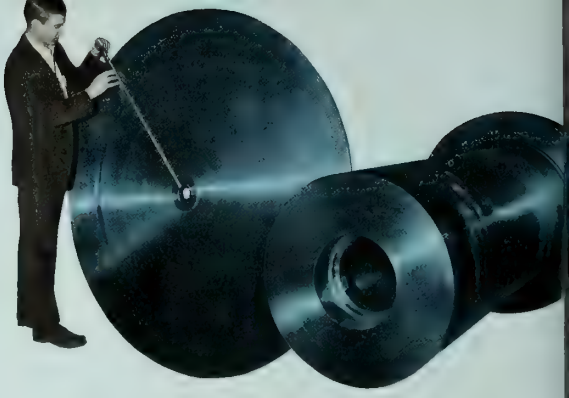
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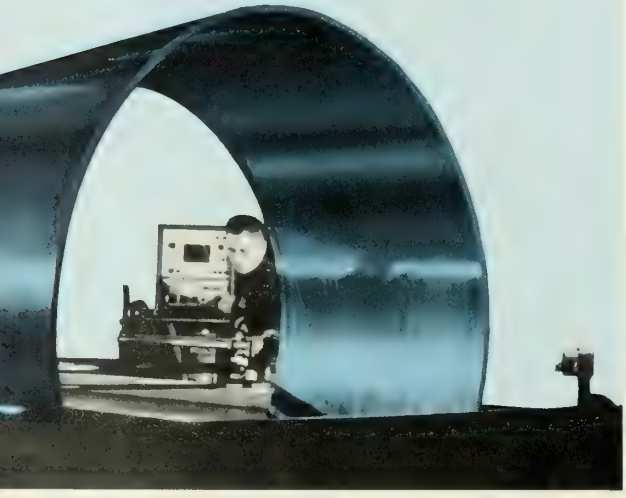


Minuteman missile motor casing of high-alloy vacuum arc remelt steel is checked for dimensional accuracy. Huge gear rings at rear are cast carbon steel.

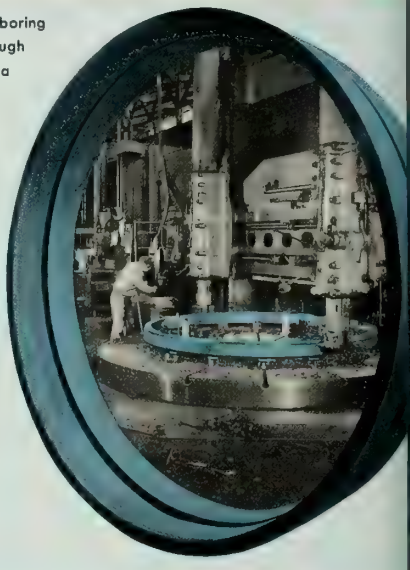


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Part II

A LOOK AT DOD IN OPERATION

How a Weapon Concept Is Approved

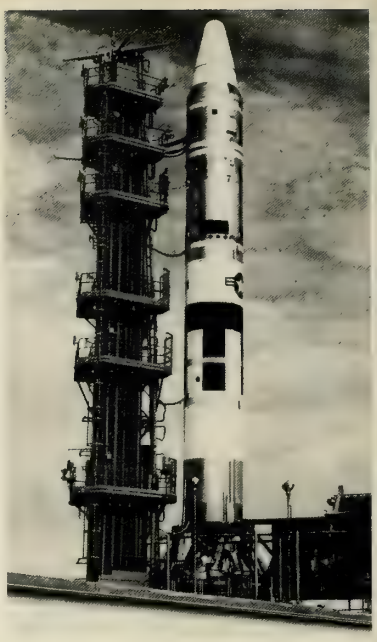
The Role of Industry

What the Critics Say

Lockheed Polaris A-3 at Cape Canaveral

Exhaustive Planning Precedes RFP Stage

Need for system, economical production capability, reasonable assurance of effectiveness must all be demonstrated



TITAN II poised for Cape Canaveral launch.

MILITARY SYSTEMS can be born at a number of points within the Pentagon—or industry—and take any one of several possible routes to fruition or frustration.

In the basic idea stage, requirements for a military system are usually formulated within the DDR&E complex (see page 40) and are channeled through the Defense Department hierarchy, down to a specific military service for issuance of Requests For Proposals (RFP).

Requirements also are generated by the services themselves and are passed up the line for evaluation.

When proposals are received from industry, they go back up the ladder within the military service involved, through the office of the Comptroller, and finally to the Secretary of Defense. On extremely important systems, the SecDef consults with the President on the final decision.

There is a variety of alternate routes which a system can take, however, as it goes up and down the chains of command. For example, industry suggestions for a new military system would start from the point of contact with the individual service, wend its way through the various evaluations by boards and individuals, and finally be referred to the Office of the Secretary of Defense (OSD) for assignment to the Director of Defense Research and Engineering (DDR&E) as a feasibility study project.

DDR&E could then issue a task order to the Weapons Systems Evaluation Group (WSEG) for a thorough analysis of the proposed system, confer with the Joint Chiefs of Staff, and report the ultimate findings to SecDef for decision.

In all the machinery are variations in procedure, depending on the characteristics, origin, and other aspects of the matter at hand. Questions on the overall series of steps taken by any one suggestion or proposal are usually answered with: "It depends. . . ."

JCS, DDR&E and WSEG

Despite the fact that a system is often formulated within the DDR&E structure or JCS or other DOD-level organizations, these organizations evaluate weapons systems, not proposals. For example, JCS, DDR&E and WSEG may all agree that a laser weapon is needed, but none of these groups will evaluate the contractor proposals intended to fill this requirement.

The requirement which is sent to SecDef after formulation by DDR&E or JCS is spelled out in great detail so that he can later decide which of the proposals submitted by industry is most responsive to the requirement and has greatest cost effectiveness. Proposal evaluation and source selection are carried out only by the service or defense agency which issued the RFP, prior to the selection board's submission of its decision to SecDef for approval.

Therefore, weapons system evaluation (method of filling a basic need) is quite different from proposal evaluation (contractor who will fill need), and those organizations primarily interested in determining the former avoid becoming involved in the latter.

Typical Procedure

A military need can be the result of a desire to counteract enemy advances, exploit our own significant scientific advances, or to explore a relatively unknown area. Establishment of the need, however, must be based on firm evidence.

It is insufficient to show that a capability exists to produce the system. It is insufficient to show that a gap exists without justifying filling that gap.

In addition to the logical need for a given system, there must be proven an economic feasibility, including the availability of resources, manpower, facilities and other ingredients.

Thirdly, the system—which presumably is needed and economically feasible—must be the best possible way of filling the need. Operational schedules and characteristics must be developed and the effectiveness of the system must be demonstrated under all likely conditions.

When all these criteria are met, the planned system must be shown to be timely; then it will be compared with all other alternative ways of meeting the need. If all these data requirements are met for each system, the flexibility of change is greatly restricted—an intentional characteristic which OSD believes will result in more careful initial planning on the part of the services.

This is the core of the present DOD philosophy: planning.

DDR&E Setup

One of the most influential offices in the Defense Department, DDR&E has a strong effect on all military systems undergoing evaluation, but does no actual contractor selection. The office is organized into five divisions, to each of which are funneled appropriate tasks

for evaluation and recommendations. Separate from these five groups are WSEG and the Advanced Research Projects Agency (ARPA).

When reviewed by one of these groups and decided upon by the DDR&E, a program will either be sent to the military for issuance of RFP or killed, subject to the approval of the SecDef. When DDR&E turns thumbs down on a proposed system, it is normally ended right there, but the SecDef can override this decision—needless to say, this seldom occurs.

During the generation of the proposed program, DDR&E works with the service involved to set up the program definition phase (PDP), which is mostly a determination of the best method of reaching the objective of the program. DDR&E, therefore, is responsible for providing technical support to SecDef in order to recommend how a system must be designed in order to meet the needs expressed by the JCS.

When JCS comes up with a military requirement—frequently in response to an idea of DDR&E—it formally goes to SecDef, who provides either initial acceptance or rejection based upon such inputs as studies by WSEG (which examines the requirements for JCS).

When the question arises as to the technical feasibility of the proposed method of reaching an objective, DDR&E comes on the scene to determine this basic question, as well as these related ones: Can technical compromises be made within the defined JCS need? In what way can we trade off such things as thrust/guidance/GSE/range/performance, in order to get the most all-around effective system?

The above, however, is not a discrete series of formal steps. The SecDef does not "approve" a proposed program and turn it over to DDR&E. Rather, it is a joint input from both JCS and DDR&E to the Secretary. DDR&E, for instance, could disapprove of the JCS approach on a technical basis, leaving nothing but a stated military requirement—thus having the effect of thwarting JCS on one hand while working with them to define a better approach to the objective on the other.

DDR&E can also broaden the technical approach to a given objective, possibly covering another military requirement with the same program and thereby stretching the dollar and increasing the effort available to solve the problem. This obviously delays the solution to a debatable extent, but also means there is a high degree of interaction among the services, JCS and DDR&E.

It is apparent that the military services are re-shaping their approaches to research and development in order to reflect the importance of DDR&E in this Administration. Additionally, there is an increase in the technical precision and degree of firm planning in proposed programs so that infeasible programs do not get too far along. The faster the services can clearly state a technical problem to DDR&E, the faster a logical decision can be made on the proposed solution.

Hitch Role

Closely meshed with the program planning procedures outlined is the Comptroller's role in determining costs and resources involved in the programs. Following the planning cycle of JCS, DDR&E and others, the Comptroller's office reviews the proposed programs for cost, manpower needs, resources, and other considerations. Based on this review, a five-year program package is drawn up and each subsequent annual budget is based on this program.

In theory, it is no longer possible for a program to get underway based on underestimated first-year costs. Therefore, a thorough cost analysis by the Comptroller's office follows the technical analysis by DDR&E and the military analysis by the Joint Chiefs.

Furthermore, the Comptroller decides which branch of the Office of the Secretary of Defense (OSD) should get primary responsibility for the evaluation of the proposed program—such as DDR&E, Installations and Logistics, or another branch—and for determining what other services might be affected. After comments from all interested parties are obtained, the Comptroller puts the ingredients into a package for the decision of the SecDef, who then has all necessary data to commit the program for development or cancel it.

Changes in this five-year program package may be initiated by any of the services or the JCS, and the Joint Chiefs are invited to comment on all proposed changes regardless of the originator of the request.

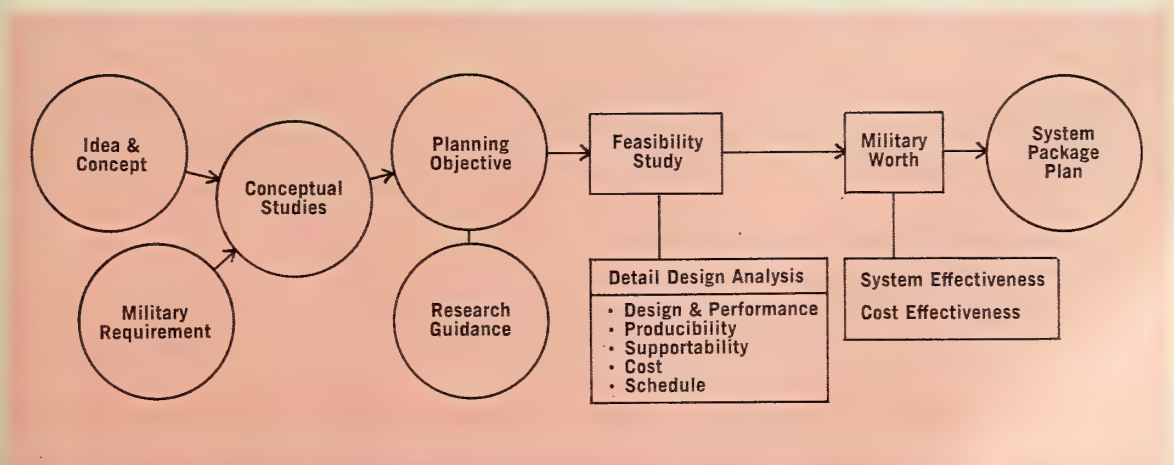
In addition to these traditional Comptroller functions, then, the DOD financial manager has a key role in military system approval or rejection. Systems analysis, for example, is now a duty of the Comptroller's office, with the objective of improving cost estimates on systems and suggesting possible alternatives.

WSEG Role

The Weapons Systems Evaluation Group plays a major role in shaping future systems by providing operational analyses for JCS, DDR&E and SecDef. The system requirements ultimately set up by the various services when they issue RFP's often have their genesis in WSEG's reports.

WSEG is mainly concerned with analysis of existing or projected weapons systems and their implications.

Inputs helping to carry out this function are obtained from industry and government sources. Corporate advanced planning groups, for instance, often share their studies and thoughts with WSEG on a reciprocal basis: not only does WSEG get the benefit of the



industrial study into applicable areas, but industry gets an idea of the sort of things the Defense Department is interested in.

In practice, WSEG gets a broad task order from JCS, DRR&E or from SecDef and proceeds to interpret the order so that a more sharply focused view is obtained. The hypothetical example of a study on laser weapons might involve agencies such as intelligence groups, the military services, and any other body having pertinent information or competence in the subject, including industry.

The Institute for Defense Analyses, WSEG's non-profit-corporation partner, supplies technical civilian input through its own Weapons Systems Evaluation Division (WSED). In consultation with the director of WSED, the director of WSEG writes out a detailed task order which may emphasize some specific portion of the original task order handed to WSEG—it depends on how the two directors interpret the initial general assignment they receive.

WSED's director then assigns a project leader to head up the study and other scientists are assigned from appropriate WSED groups: mathematics, costs, aerospace defense, tactical warfare, and command and control.

WSEG's director, meanwhile, assigns military people to the same study to provide operational and industrial data inputs. When the study is complete, a review board goes over it carefully to see if it answers the original question asked of WSEG. If so, it is processed as an official report and given to SecDef.

A WSEG report usually doesn't conclude with a clear-cut yes-or-no answer. The conclusions instead often tend to support both sides of a technical question, depending on who is using the report and what qualifications he places on the initial question or problem.

The group's reports—among the more influential documents in decision-making—cover "far-out" topics frequently. For example, a typical WSEG study might be: "What are the implications of lasers as offensive weapons?" Such a study must include such considerations as: "Shall we begin an all-out effort to develop a laser gun? What is the present state of the art of lasers? What would be the cost of development compared with development of a competing system? What efforts would have to be shelved in order to favor this one? What new military tactics or strategy might this development call for?"

Such a report would comment on certain things like the cost of the anticipated program and the general operating characteristics to be expected of the end product. It would then be up to SecDef, using the WSEG report as one of a number of inputs, to determine if such a program were in the national interest. If so, he would start operation of the machinery described above. The WSEG report would go not only to SecDef but also to DDR&E and JCS for their comments.

Considerations

What types of considerations are taken into account when the overall system proposal is being evaluated? An example is provided by AF Systems Command practice.

When a new military system is being suggested for adoption based on an idea, it must first be basically determined that a militarily useful system could spring from the idea involved. To answer this question, a conceptual planning study is initiated by AFSC with three industrial contractors and an AF in-house team participating. The resulting technical feasibility analysis includes establishment of the operational environment and the producibility of the proposed system. With these broad inputs established, a preliminary design configuration is laid out and the broad performance characteristics described.

Other wide-ranging determinations include cost estimates, time period of initial operational capability, producibility, supportability and operability. When these basic and general outlines have been tentatively fixed, advanced planning groups carry out parametric analyses to assist in finding optimum solutions to problems anticipated during development. It is at this point in the AFSC cycle that the major use of electronic computers comes into play.

The number of trade-off's and solutions in a study of this type run into six figures. A million configurations of an aircraft, missile or space system can be analyzed in a few hours, and when cost figures for each configuration are included in the equations, the optimum combinations for both parameters are arrived at.

Preliminary design analysis is the next step, resulting in design point studies of various configurations of aerodynamics, propulsion, structures, and functional subsystems. Mission subsystems are integrated and the overall system performance analyzed, with complexity increased proportionally with the system's sophistication.

This analysis, consisting of specific configurations and subsystems along with performance and effectiveness data, provides facts for the decision to develop the system, identification of critical problems, and expectations on performance.

It has happened (in the VTOL aircraft, for instance) that a program reaches this point and is found to be infeasible at the time of analysis. In such a case, the requirement is shelved until subsequent events either allow its fulfillment through improved technology or approach, or the requirement ceases to exist.

Prior to the present Administration, the preliminary design phase and its cost analysis were concerned with initial development costs, production costs and operating costs of a system. Now, cost analysis also includes facilities, training requirements, maintainability, supportability and other factors in what is referred to as "cradle-to-grave" cost estimating.

The four principal factors at this point are design, operational concept, production quantities and program scheduling. In the more detailed analysis of the costs involved, there are three general phases: research, development, test & evaluation; procurement; and annual operation.

After ascertaining costs, realistic timetables and producibility, the next step is to carry out an effectiveness analysis. This is simply the determination of whether or not the system meets the stated military requirement. Frequently, AFSC has found, the realistic performance which is calculated is somewhat less than that envisioned originally.

Final Factors

Closing of the complete job depends on the answer to a final broad question: "Is this system or concept actually worth its cost in terms of effectiveness obtained?" Known as military worth, or cost/effectiveness, this complex question takes into account such things as overall national objectives, ability of competing systems to do the job, and the degree of risk involved in making a decision.

Usually, the cost/effectiveness study is a comparative matter inasmuch as the military service must have some alternatives in mind to ascertain whether or not the system should be pursued. The results, therefore, are a logical set of arguments and data which allow an intelligent development decision to be reached. There are three conclusions:

- Development should be initiated;
- The concept is undesirable, therefore development is not advisable;
- The concept is desirable, but the overall worth is questionable; therefore, additional R&D should be continued but development should not be initiated.

Based on one of these three conclusions, then, the service will either issue RFP's based on the desired characteristics, send a report of its analysis back up through channels, or let study contracts for further work.

Receipt of industry proposals by the service is followed by careful matching of the proposal contents to the established need, the estimated costs and other aspects of the military conclusions as drawn form the series of analyses. ■



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Reorganization Prompts Closer Liaison

White House, Congress, State Dept. and NASA increasingly consulted in budgetary, politico-military and space matters

FOUR "FIRST LINE" institutions have a voice in Department of Defense policy formulations, and several other agencies exert influence on DOD planning.

The most influential bodies with which DOD has a continuing and increasing need for close formal liaison are the White House, Congress, the State Department and NASA. Of these, Congress has the most overt role, and the 88th Congress is already in disagreement with elements of Secretary McNamara's statement of U. S. military posture.

CONGRESS

McNamara's 1964-1968 military posture statement has been delivered to the House and Senate Armed Services Committees, and to the two appropriations committees.

The Secretary's statement was prepared and given to these committees before he appeared at hearings with each. This enabled committee members to develop policy and procurement questions to be answered by McNamara at the respective hearings.

After the Secretary of Defense presented this overall statement of the condition of U. S. military forces around the globe, against which his Fiscal Year 1964 arms-authorization request must be weighed by Congress, he was followed to Capitol Hill by JCS Chairman Gen. Maxwell Taylor, the secretary of each service and the military chief of staff for each service, and finally by Dr. Harold Brown, Director of Defense Research & Engineering.

Each testified before the House and Senate Armed Services Committees, and the two appropriations committees, regarding his agency's needs in the arms-authorization bill. Brown appeared on behalf of the Advanced Research Projects Agency.

Most of the testimony of these hearings is classified, but one DOD source told MISSILES AND ROCKETS that some of this year's closest Congressional queries came from the House Appropriations Committee. The most topical weapons programs, this source said, were *Nike-Zeus* and *Nike-X*.



WHITE HOUSE and State Dept. play expanding role in shaping defense policy.

Congressional and Pentagon sources both felt that the close questioning regarding antimissile defense had been prompted by Soviet claims that they had mastered antimissile technology. This is an area of weaponry in which the State Department is also vitally interested.

State Department officials told M/R that an antimissile missile gap could have powerful political implications in the East or West leanings of neutral bloc and underdeveloped nations.

- **The Whiz Kids**—Regarding the much-publicized controversy over the downgrading of military professionals in the Pentagon in favor of the so-called civilian "Whiz Kids," one DOD expert on legislative affairs says the House Armed Services Committee has displayed the most interest in this area.

But, says this source, "If I were a better defense historian, I could probably tell you that this current criticism —that traditionally military decisions are being made by a civilian secretary and staff—is very little different in motivation from the big battleship controversy that developed toward the end of World War II."

STATE DEPARTMENT—ISA

A newly emerging influence in DOD matters is the State Department's Office of the Deputy Assistant for Politico-Military Affairs (G/PM), headed by U. Alexis Johnson. This agency began as a one-man office in May, 1961. It was quickly recognized that State was kidding itself that one man could handle the complex political implications created by the size of the post-World War II DOD establishment.

State Department officials are quite candid in admitting that DOD first recognized the need for institutional DOD-State Dept. liaison machinery. DOD set up the office of the Assistant Secretary of Defense for International Security Affairs (ISA) shortly after World War II. The office is currently headed by Paul H. Nitze, who describes it as being at the crossroads of State-Defense-JCS relations.

- **ISA functions**—ISA is responsible for staff communications between the Pentagon and State, the White House and other relevant agencies in the foreign political-military and economic-military fields.

ISA also exists as McNamara's own in-house staff in the politico-military field to help him take an independent DOD look at the point where military advice from the JCS, political advice from State, directives from the White House and advice from other governmental agencies interact.

Nitze represented ISA at the Nassau meeting between President Kennedy and Prime Minister McMillan. In that in-

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CONGRESSIONAL committees closely scrutinize details of DOD budget, planning.

stance, it was ISA's function, in conjunction with State, to lead off with the foreign government in the *Polaris*-for-*Skybolt* agreement, and to make recommendations from a DOD point of view regarding the politico-military ramifications of the agreement.

• **G/PM role**—State's Office of Deputy Assistant Secretary for Politico-Military Affairs (G/PM) has grown from its one-man inception in 1961 to a current staff of some 15 professionals. Again, spokesmen for G/PM are frank in saying that their operation is not as sophisticated as it should be. They add, however, that its voice is growing in authority, and its future is bright.

While a good deal of the contact between the State Department and DOD still is at the bureau level (European bureau, Far Eastern bureau, etc.) there is increasing liaison between G/PM and DOD. G/PM does not exist to discourage field foreign service officers from communicating directly with DOD or an interested branch of service. It mirrors the in-house politico-military expertise that has existed for some years through the workings of DOD's office of International Security Affairs.

G/PM sources say the Kennedy Administration has been more interested than any of its predecessors in the political implications of military problems. Secretary Rusk provides guidance on DOD's budget, supported by the recommendations he receives from the G/PM office.

Though Rusk may not question such matters as the number of a certain type of missile that are to be procured, he points out the political implications inherent in such a situation as the lack of an operational U. S. antimissile capability.

• **Industry-State relations**—G/PM representatives told M/R that there is little direct contact today between industry and State regarding advanced planning on weapon systems, but at least one source in the office looks for increasing State-industry relations.

He says this will come about because weapon systems are now being designed for more specific purposes—even for use in specific geographic locations. This is one area in which States's G/PM expertise will be helpful to industry in the future.

Finally, in analyzing G/PM's influence on DOD planning, a G/PM spokesman says that his office is uniquely qualified to offer advice on military matters that cut across single State Department bureau considerations.

The Atlantic Missile Range is a good example of the involvement of more than one State bureau, since it is so situated that both Latin American and British implications of the range's operations must be weighed.

THE WHITE HOUSE

A military aide to President Kennedy says the chief executive's influence as the ultimate formulator of national policy is exercised in the DOD realm in four or five formal ways.

DOD's preliminary budget proposals offer the President an opportunity to discuss military posture with McNamara and the JCS. Both McNamara and Deputy Secretary of Defense Roswell Gilpatric joined President Kennedy and the JCS to "thrash out" the budget at Palm Beach, Fla., during the President's last Christmas vacation there.

The President questioned procurement goals, and suggested alterations.

• **Atomic delivery capability**—Then at least twice a year the President and DOD review U. S. atomic delivery forces to assess that capability in the light of intelligence reports. Again, the President has the final word on how many ICBM's or other delivery systems should be procured.

Meetings of the National Security Council also have an impact on DOD hardware procurement and long-range planning. Gen. Taylor now sits in on these meetings as Chairman of the JCS.

The President meets with all the Joint Chiefs every three or four weeks. Again, procurement or contracting of a specific weapon system could be on the agenda at any of these meetings, and the President can make recommendations that shape DOD programs.

Beyond this formal framework of contact between the President and elements of DOD is a more relaxed working relationship with the JCS that has typified the Kennedy Administration. The President has been known to call more junior members of the Joint Staff to the White House for a briefing on a particular program in which the Chief Executive is interested.

NASA

The federal agency with perhaps the greatest effect on DOD—at least in the missile/space field—is NASA.

This is illustrated by several agreements between the two that provide for cooperation and coordination in development of space systems.

• **Gemini cooperation**—Perhaps the most important is the NASA-DOD agreement covering management of the *Gemini* two-man space program. Besides permitting Air Force participation in the program, the agreement provides that neither NASA nor DOD can initiate new manned spaceflight projects in near-Earth orbit without permission of the other.

A similar agreement covers launch-vehicle technology. In that area, before DOD could move ahead with its big solid-motor program, it had to insure it would meet NASA requirements.

To improve its relations with DOD, NASA has established the Office of Deputy Associate Administrator for Defense Affairs. The job currently is filled by Adm. W. F. Boone (Ret.).

Most of the coordination between the two agencies is handled by the Aeronautics and Astronautics Coordinating Board. It is directed by cochairmen Dr. Harold Brown, and Dr. Robert C. Seamans Jr, NASA Associate Administrator. ■



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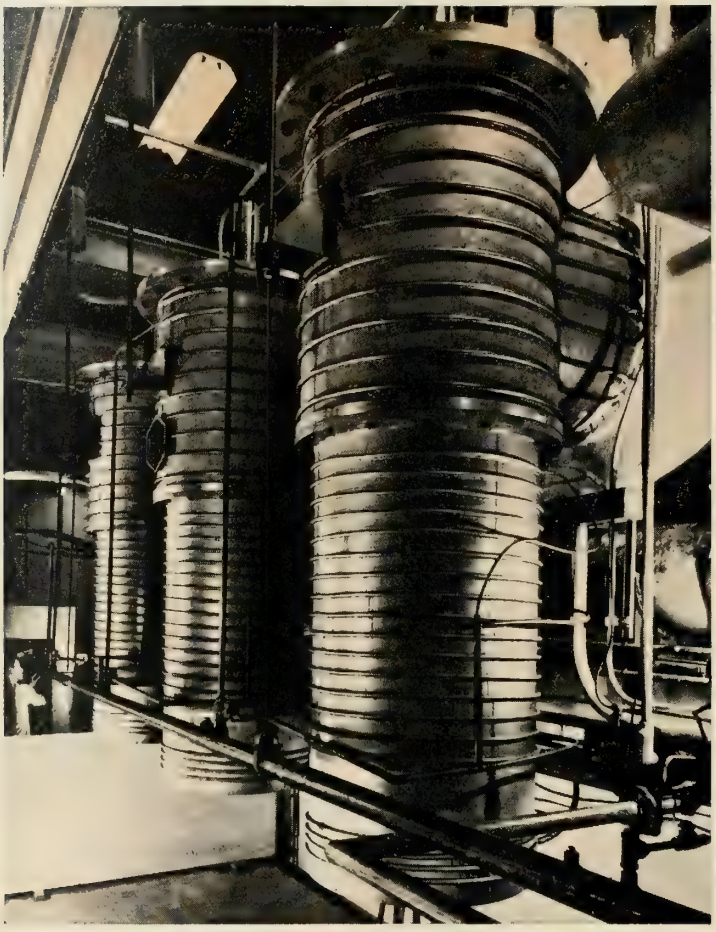
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Firms Must Anticipate Future Needs

Many companies now have long-range planning groups which try to figure out Pentagon decisions in advance

INDUSTRY'S advanced-planning departments have taken on an increasingly important role as business dealings with DOD have become more complex.

While in some companies advanced planning still is done by executive offices, many have formed formal organizations. All agree that this function has increased in scope and emphasis in the last decade.

These groups must turn out long-range intelligence on government requirements, including rundowns on project funding and RDT&E for each service. Not only must they outline a projected budget picture, but they must also identify each technology in which the company should be investing in a research and development effort to meet it.

What it basically boils down to, says one West Coast company executive, is "trying to figure out what recommendations the DOD comptroller's office and the office of the Director, Defense Research and Engineering are going to make."

• **Anticipating DDR&E**—The same procedures of cost effectiveness analysis, system analysis—these things industry must do as well as the Pentagon. It must figure out objectives of the DDR&E as well. If an advanced-planning department is doing its job well, it should be able to come up with much the same conclusions as DOD, since the same information is available to it, says a planning group head.

When the planning team gets this information, it indicates into which programs the company should put R&D money.

Many factors have arisen in the last few years to complicate the job of the planning expert.

Lead time is shorter. Says one contractor: "If we open our mail and see a request for proposals on a ballistic missile system, with bids due 60 days from then, we are not interested. This immediately tells us that another company wrote that RFP, did a lot of work in that area, or established the requirement. If we weren't in on it then, there is no time to catch up.

"There's no point in wasting your money or the government's by submitting a frantic proposal at the last minute," he says. Another contractor estimates that lead times necessary in marketing have been accelerated by three or four times what they were five or six years ago. This necessitates a lot of groundwork in the important areas well in advance of issuance of a total system requirement, he points out.

There also are a lot more people to talk to. While companies previously dealt mostly with the services alone, DOD now is superimposed on that structure. In addition, other agencies such as the State Department must be considered. Then there are ad hoc panels and non-profit management corporations with which contact must be maintained.

• **Management firms important**—These non-profit management firms have become very important references for the advanced-planning groups, industry spokesmen say, since as technical monitors or designers of systems they will determine the nature of many programs.

A more formal atmosphere now exists between DOD and industry. "The era has passed when a field office representative could go into the military, put his feet on the desk of an OSD man, and say "What's new?" Now the field office must work in conjunction with an advanced-planning department.

Industry can't now make as many bold proposals as it once could. If a proposal seems to be a bigger step at one moment than was contemplated at that time, the company has a hard time convincing the government that it needs it, says another industry representative.

The company must always bear in mind that getting an RDT&E contract does not mean a "womb-to-tomb" relationship with the project. "You can't afford to sit back and say you've got even all of the RDT&E captured, because you've got to really perform," contractors say.

These problems have required industry to choose the highest caliber thinkers for its planning departments. One industry executive said he looked for the generalist, a person who looked past little details to broad, overall thinking. Another remarked that marketing personnel have to be more skilled, more able to penetrate to be sure that the company is meeting the demands of competition.

• **Positions changed**—Advanced thinkers must also be informers. Industry's role in the flow of information between DOD and its contractors has practically switched, one company executive pointed out. "Back at the very beginning, notions for what was feasible for missile systems kind of bubbled out of industry, and from these came suggested strategic concepts—an information line from industry to DOD. Now, DOD top-level people clearly are setting the concepts."

However, a good flow of information has been enabled because many former OSD people are now in industry, and many industry people are now in OSD, he notes. "We have to learn to go in and speak to these people in DOD, keep them continually abreast of what we are doing. Then they can put it all together and keep informed."

Another function the advanced thinkers in industry have, contractors say, is keeping the various ad hoc scientific panels informed. While they don't issue contracts, they create policy for those who do and thus must be informed.

In addition, company officials must be encouraged to serve on and be available for such ad hoc panels. These people become very valuable to the company when they return, since they gain considerable insight into DOD's thinking.

Information is available to advanced-planning groups at almost any level in DOD. Contractors may request to be put on mailing lists for certain types of information. Even classified information is readily available on a need-to-know basis. ■



9:06 A.M. *Off on early hike through Pentagon is Martin-Orlando representative Jean Kossarides, headed for discussions at both service and DOD levels.*



9:12 A.M. *Kossarides briefs Army official Charles Poor on a Martin Co. proposal.*



2:00 P.M. *Kossarides drops in on Col. Ted Metaxis at the Joint Staff of JCS.*

DOD / *industry liaison*

Pentagon Salesman's Day Is Busy One

ONE DAY earlier this month, Jean Kossarides, a former test pilot who is now a military sales representative for the Martin Co.'s Orlando division, set off on his Pentagon rounds.

Like most industry representatives, Kossarides has found that the McNamara reorganization of the Dept. of Defense has brought changes in the way he does business.

A military sales rep's job in Washington is a two-way street. His primary task is to tell the military services about the products and capabilities of his firm. But he also serves as an intelligence source for his company.

● **Questions and Answers**—What new military requirements are in the wind? Who is getting the major new contracts? Will there be directed subcontracting and on what systems? He probes for these bits of information—across Pentagon desks, over the luncheon table, in the halls of Congress and at Washington cocktail parties—and passes them along to the planners back home.

Technical competence is a must and so is an ability to get along with a wide variety of people.

But the industry representative making his rounds in the Pentagon today is getting along with people on a higher level than ever before—if he is doing a good job. Previously, his most important contacts were in the Army, Navy and Air Force. The individual services were making the decisions on what weapons systems to procure and on what companies to procure them from.

Robert McNamara changed that.

"You get the feeling when you talk to the services these days that they aren't really making any important decisions, that the decisions all are being made upstairs," says one Washington rep. "I'm spending more than half my time now at the DOD level."

Jean Kossarides agrees. When he calls at the Pentagon, he now is doing as much walking and talking in the corridors of the Office of the Secretary of Defense as he does on the service levels. An occasional visit to the White House staff and to the Hill also is on his schedule.

The individual services can't be ignored. Contacts there still are of value. Frequently, they are sources of valuable information on the thinking both at



10:30 A.M. *He is in the office of DOD's Robert Benneche to talk about RACEP applications in ASW problems.*



12:45 P.M. *Discussion of communications satellites with AF Lt. Col. Frank Jaeger (left), Col. Robert Dickerson.*



2:25 P.M. *Departure from Pentagon might mean a visit to White House staff or State Dept., but today it's Capitol Hill.*



2:56 P.M. *Martin salesman and home-state Sen. George Smathers (D-Fla.) compare notes on Washington trends.*

OSD and service level. Frequently, they can help the military salesman sell his program upstairs. Technical evaluations are carried out at service level, as well as in OSD.

● **Friends and Allies**—The military service today is in closer natural alliance with industry than ever, for the services themselves have become sellers instead of buyers—selling concepts and hardware to the civilians of OSD.

What it adds up to is this: the military sales representative must continue his old relationship with the services, probably in a more cordial atmosphere than ever before. At the same time, he must build a complex new level of relationships above this—contacts at DOD level, the White House, the Hill and even the State Dept. For all of these now are an influence in procurement.

Kossarides finds this new activity taking up much of his time on his frequent visits from Florida.

"It's not easy," warns another military salesman, based in Washington. "You can't get to drink and play golf with these Ph. D.'s the way you do with the old crowd. It's a more formal, less friendly relationship."

There's a good chance that the relationship is stiffer because it's newer. As friendships develop in the years ahead, golf with a DOD civilian may become as commonplace as golf with a friend in uniform. But for now, many military sales representatives are finding it tougher sledding.

● **Intelligence and Sales**—The way Kossarides sees it, the requirements for a professional military salesman remain the same. He must:

● Try to determine a military requirement before it becomes common knowledge to the rest of industry.

● Seek out priority and budget information.

● Determine all the agencies and individuals to be involved in a program.

● Assess the competition and its technical approaches.

● Help develop the strategy and tactics to sell the program.

● Sell the program.

A salesman must have contacts at the levels where this information can be found and he must have the detailed military and technical knowledge to sell his concepts and systems.

"These contacts and knowledge are directly related to time," says Kossarides. "Therefore, the longer he is in this field of endeavor, the more successful a salesman will be."

● **Walking and Talking**—Equipped with this background, the military sales representative depends on walking and talking to do the job.

When Kossarides dropped in at the Pentagon this month, the Martin-Orlando salesman headed first for 3E385, the office of Charles L. Poor, special assistant to the Army's Asst. Secretary for Research and Development.

The two men discussed a new air defense system, talked over the possibilities of a proposed antitank weapon.

Then on to a Navy office to talk over antisubmarine warfare and a visit to the Air Force to brief a group from the Directorate of Command Control and Communications on possible future uses of Martin's RACEP communications system. A visit to the office of the Joint Chiefs of Staff for a discussion of counter-insurgency weapons was followed by a trip to the Capitol to exchange notes with Florida's Sen. George Smathers.

A not unusual day in the life of a military sales representative in Washington. But it's one that has changed a lot since Mr. McNamara took office. ■

Contractors Find Flaws in New Regime

Company spokesmen praise aims of new policies but complain about 'cost effectiveness' approach, political pressures

DOING BUSINESS with the Pentagon is a lot different than it was three years ago—and industry is greeting the change with mixed emotions.

Much of the difference admittedly may be due to the changing nature of weapon systems. Their increased complexity and phenomenal costs have produced inevitable managerial adjustments.

But there is no question that the new Administration's policies—centralization of authority and establishment of new management programs—have themselves made necessary a considerable adjustment by industry.

In general, missile/space industry leaders endorse the aims of the new Dept. of Defense policies. These are the reasons cited:

- The dollars are being better monitored.
- Wasteful duplication is avoided.
- Addition of more technical people to DOD staff has improved communication between DOD and industry.
- Long-range planning is easier.

Some industry people also feel that the end result of Secretary McNamara's coordination will be a more effective marketing environment, which ultimately will stimulate more competition in the market place.

But what is good in theory has not always been welcomed in fact. There is sharp criticism of today's DOD operation by some of the biggest and most regular defense contractors. Top industry executives assert that:

- The McNamara yardstick of "cost effectiveness" is destroying initiative in research and development: "If you are 100% sure something will work and how much it costs—that's not R&D but production engineering. It's obsolete before you start."
- The policy of directing research at just a few large weapon systems is causing neglect of other technological areas: "We don't have any cushion to protect ourselves if we need to change," says one industry executive.
- Politics is playing an increasingly large role in award of contracts—and subcontracts.
- In too many cases, non-technical people are making the decisions: "It's lowering the quality of our systems."
- Decisions are coming out at a much slower rate because they have to go all the way to the top.
- Paperwork generated by Administration requirements is backbreaking—and is driving small contractors out of the defense business.
- Industry now must deal at too many different levels of the Defense Dept. Primary concerns are with the Comptroller's office and with the Director, Defense Research and Engineering. But there still is a great deal of communication at the service level, although as one industry representative put it, "you know intuitively that these people are no longer making any decisions. But you can't go over their heads too much and still have them talk to you."

The fact that DOD now handles entire weapon systems as packages causes some industrial chagrin. If a weapon system is to get approval, it must be defined right down to spare parts and training manuals. Birth-to-death cost effectiveness studies are required.

Says one contractor: "We are beginning to get well-costed, mediocre systems because industry tailors its programs to get past Comptroller Hitch. It no longer thinks of how advanced a system it could produce, because it won't get funds."

An example used in the missile defense field is *Plato*, which didn't come out well cost-wise. It was re-studied and re-done as *FABMDS*. *FABMDS* still didn't make it, and the re-studied, re-done version is *AADS-70*. Meanwhile, there's still no system.

Too many advanced concepts are being studied to death and dying in the DDR&E shop for lack of aggressive R&D funding, contractors say.

Even after a program is funded, a contractor tends to play safe, another spokesman remarks. "With the amount being spent on the system, you don't dare to make a mistake, so you back off and build something that is fairly sure."

The best situation, this particular contractor feels, is to conduct a reasonable number of expeditions into prototypes with a hard-hitting R&D effort. More chances would be taken and several choices would be produced. Thus, a better, more advanced weapon system would result.

A byproduct of this approach, other contractors pointed out, is that it would keep the Russians guessing.

- **Contracting**—The McNamara five-year cost-reduction plan calls for several changes in contracting.

Replacement of negotiated contracts by more competitive procurements is meeting with some resistance in the missile/space industry.

Critics say the government may be getting a better initial price but the end result is not necessarily cheaper. It is pointed out that an unqualified contractor may lose time, give less quality, or lose his own shirt fulfilling an ill-ad-

(Continued on page 68)

Barbs Come from Congress, Military

INDUSTRY is not alone in its criticism of the present method of operating the Defense Department. Both the military services and Congressional leaders have some pointed —though by no means parallel— barbs to aim at the McNamara administration.

General congressional attitude is that McNamara and his immediate associates are highly intelligent, logical and sincerely concerned with making up the best military force possible, within given budgetary limitations. The Senate side of the Capitol, for example, has expressed the feeling that it is "quite satisfied" with the way DOD is being run.

Only when it comes to specifics do Congressmen on both sides become very sharply critical of individual decisions such as the *Skybolt* cancellation.

• **Military comments**—Not so willing to grant McNamara a favorable verdict are the military services, generally peeved at the DOD administration—with some notable exceptions. The Army is quite happy over the expansion of its own air force and general purpose forces, but is still struggling to get DOD to see the light on the *Nike-Zeus* or *Nike-X* systems. Army wants production and deployment on a rapid timetable.

Navy is somewhat edgy about that McNamara comment: "The entire question of the cost and capability of the fleet in relation to the cost of defending it against air attack is still in need of a most thorough analysis." His inclusion of this eye-opening sentence in such a well-studied document as his statement to the Congress has led to considerable speculation and concern.

Air Force is obviously the most frustrated and bitter of the military services. Although its ICBM programs are virtually unchallenged, it has lost its bid for continued manned bombers, air-launched ballistic missiles, and a major role in manned space programs.

Nevertheless, one AF R&D expert said: "It isn't that DOD has a negative attitude on space, it's just they've got a very conservative attitude—and they'll give us what we need if we can prove we need it. But with a new and uncharted field, how can we possibly satisfy their criteria of a need?"

To illustrate his point, the critic cited the requirement that all programs budgeted for more than $2 million in the category of of general R&D must be approved by DDR&E. In contrast, any military R&D program connected with space must be referred to DDR&E for approval if it exceeds $200,000—or only one-tenth the level.

Overall military criticism of the Defense Department includes the comment that DOD is doing too much project management and getting into the details of a program, rather than delegating this responsibility entirely to the service. The result, say service critics, is that initiative within R&D offices is inhibited by the over management because the R&D people no longer have much control over their end product.

Formerly, an AF proposal generated in-house was almost always in friendly hands, even if those hands were critical and turned thumbs down on the idea. Now, everything must be given a "hard sell" to DOD executives—many of whom, it is charged, have no appreciation for the military aspects of a proposal.

"We simply have not been given the responsibility of selecting those systems which we will someday be expected to use—and win with. This is one of the most basic and necessary responsibilities of the military," stated an exasperated AF spokesman in discussing the RS-70, *Skybolt* and military space situations.

• **No R&D drought**—One point on which industry and the military disagree is that of replenishing the U. S. reservoir of research and technology information. Some industry leaders have criticized DOD for being too weapon system-oriented and insisting that all R&D be connected with some specific system.

This is not the case, says the military, noting that the amount of R&D on non-system-oriented tasks has increased. The Defense Department now has an estimated half-billion dollars in research work which is tied to no system whatsoever.

As for the planning aspects of DOD's program package approach, there is wide agreement that the program definition phase (PDP) is an orderly approach, but one which sacrifices priceless time in the name of economy. This reduces the risk but loses time to a potential enemy. "This approach is not very bold, to say the least," charged a Navy R&D man.

In a very similar vein, an Air Force missile expert said the ballistic missile could not possibly have been produced under the PDP concept in the time it was. It would have been more economical that way, he said, but it probably would have taken a dozen years to get the systems ready. Other sources have already made a classic example of the atomic bomb project as one which could not possibly have been completed successfully under PDP methods—they say the program probably would never have gotten off the ground.

• **Mythical organization**—One of the more difficult criticisms to document, but one widely accepted in both Congress and the military services, is that the Defense Department organization chart is merely for external consumption. It has been charged that the small group who surround Secretary McNamara play a decisive role in the fate of nearly every program in defense.

The "Whiz Kids" allegedly use an informal "bull session" approach to discussing a problem, despite what the organization charts say about the procedure . . . a situation likened to Andrew Jackson's "kitchen cabinet."

The biggest complaint in this light is that more personal opinion, politics and prejudice could enter into the decision-making process than is admitted. This unscientific approach is usually attributed to the DOD after a setback has been suffered by the critic's service, and the man most often fingered as the one who wielded the hatchet is Dr. Harold Brown—who seems to have alienated many military and industry people.

Military and industry people voice one criticism that is not shared by Congress: they complain that major decisions on service programs are made without regard for the service secretaries. It is widely felt in the military that the DOD is so centralized that the service chiefs no longer wield enough influence to save the situation. On Capitol Hill, the service secretaries testified that they did not feel any erosion of their authority and responsibility has occurred in the past three years. Virtually everyone else in the Pentagon disagrees.

	EXCELLENT	GOOD	FAIR	POOR
Fiscal Control	✓			
Quality of Systems Research & Development				✓
Basic Research				✓
Technical Quality of Procurement Decisions		✓		
Resistance to Political Influence				✓
Elimination of Wasteful Duplication	✓			
Communication with Industry		✓		
Program Packaging		✓		
Speed of Decisions				✓
Subsystem Research & Development			✓	
Paperwork Requirements				✓
Proper Use of Non-profit Firms			✓	

Pentagon Report Card: How Industry Rates DOD

(Continued from page 66)

vised low bid. If his other government contracts suffer, or he ultimately goes out of business, DOD loses.

• **Politics**—Most serious of all adverse reaction within the missile/space industry is the feeling that politics is playing a dominant role in contracting.

When three or four contractors make large advances in the state of the art during their work on study contracts (which usually require considerable in-house funding support) and another company which has not done this work gets the R&D contract, "something else obviously came to the fore," one contractor said.

When all things are equal, and a contract is then given to the company which needs business or is in a depressed area, this is regarded as understandable. But when an unqualified contractor is chosen for no other apparent reason, suspicions naturally result.

These factors are present now even in the second and third layers of contracting, one source told M/R. A representative of one of the largest and most experienced firms in the government contracting business, this man said he knew of at least three instances in which his company had been required to take a less qualified sub-contractor on a major procurement over the one the company had selected. There seemed to be no justification for the imposition except politics, he said.

It becomes especially unbearable when the government requires a contractor to fit into his system parts that were designed for a competing, perhaps conceptually different system, just to give that subcontractor some work.

Another major contractor dealing with a different type of product said that he had seen no known instances of directed subcontracting in his firm, although the government has asked the company on a number of occasions to "look" at a certain geographical area or certain companies. This did not amount to a directive, he said.

• **Paperwork**—Industry executives say that regulations are increasing to the extent that administrative costs are burgeoning. For instance, it now takes about two years of paperwork just to close a contract.

At least one large firm has turned subcontractor to avoid dealing with the government. Many small firms are finding the overhead costs unbearable—even if it means idle equipment.

• **Restrictive practices**—One of the most onerous requirements is the rights and data clause. Almost all interviewed agreed that it has been intensified under this Administration. The clause, which requires that a contractor disclose specific skills he learns while performing on a government contract, holds a financial penalty for non-compliance.

The clause is particularly hard on the prime contractor, who has the job of enforcing it on subcontractors. In some cases, the sub—who's already been paid—thumbs his nose at the contractor.

Some companies have refused to work under the clause. Companies with only one or two product lines are not willing to disclose their production methods.

• **Basic research**—Concern is being voiced throughout the industry that basic research is suffering from the weapons system package concept.

The poorest effort in DOD today, says one industry representative, is in the supporting research groups. Just as you don't run a garage without any parts on the shelf, he says, you can't exist without supporting research.

Another echoes this belief that the basic research laboratories supported by the government are not doing the job they used to. Perhaps it's lack of motivation, or the absence of a force to charge them up. He suggests a hard look be taken at these labs in terms of what they have done in the last few years compared to previous years.

• **Small business**—Small Business Administration policies are another source of irritation to major firms. One prime contractor feels quite strongly: "It's not worth the money put into it." He cites an instance in which his company had to bail out a small firm which simply was not able to produce and, in fact, contracted for production of an item it didn't have the equipment to produce.

• **The think factories**—The nonprofit corporations set up to do some of DOD's thinking did not receive a high rating by industry representatives.

"Some of them have really been off base," says one spokesman. It's an expensive way to buy an ineffective report."

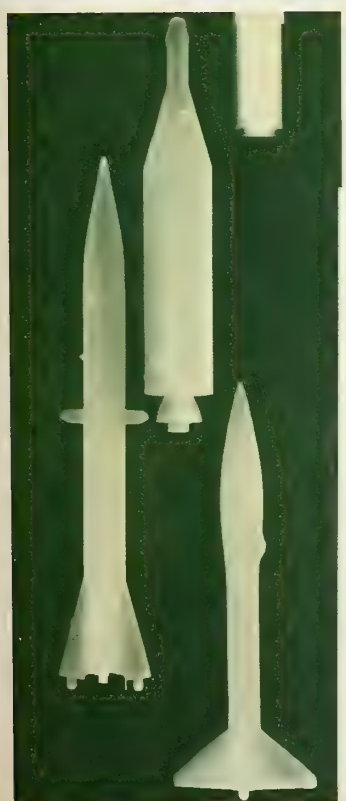
Much of the criticism is directed to the fact that many of the policies suggested by the think agencies are not tailored to the DOD-contractor situation. One executive likened it to the difference between a company having house counsel, or just retaining independent, outside legal advice.

The recent Logistics Management Institute survey, for instance, drew up a formula for assessing proper profits (M/R, Feb. 25, page 15). Much of it looks hard to enforce, even by DOD admission, since it is couched in general terms. ■

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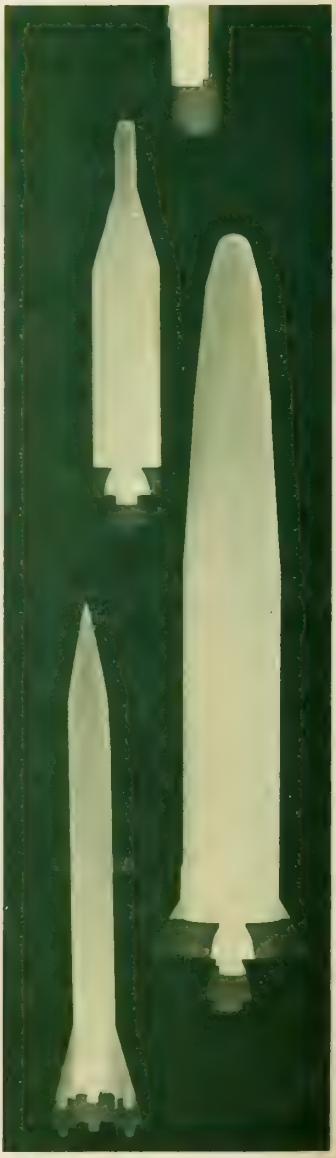
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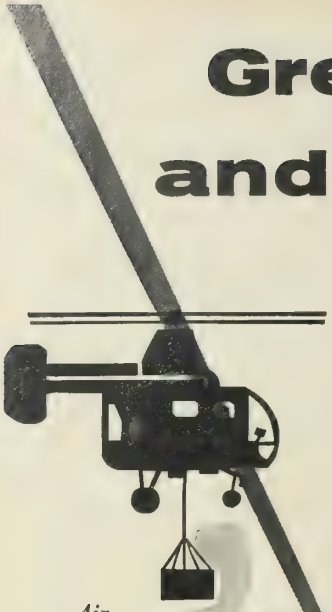
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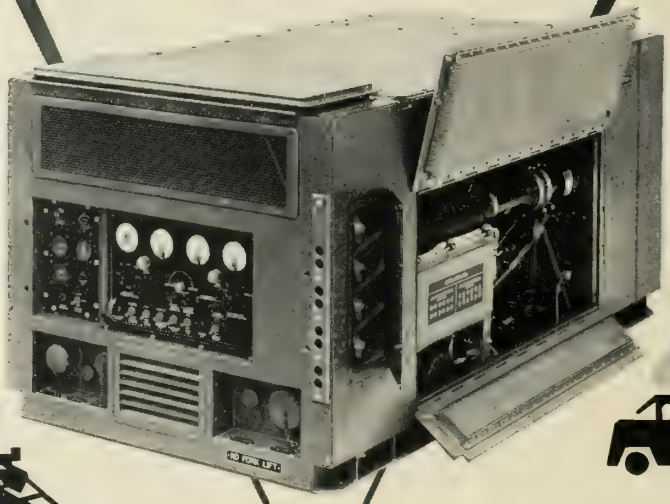
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MARTIN Pershing rises from Cape Canaveral.

Part III

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Secretary's Authority Reaches Peak

McNamara has implemented laws giving him enormous power; service secretaries lose sway; Gilpatric is strong deputy

THE DEPT. OF DEFENSE is without doubt the most complex structure within the U. S. government. Since World War II, Congress and the Executive Branch have struggled to bring some order to what is now both a single executive department and at the same time a complicated mechanism for the defense of the nation.

Throughout this period, the powers of the service secretaries have declined while the authority of the Secretary of Defense and his staff has increased.

With the advent of Robert S. McNamara, the trend has reached its peak. There is little doubt that the variegated structure which is DOD now is firmly in the grasp of one man.

McNamara brought with him to his job a management ability not possessed by any of his predecessors. He has not rewritten the book in reorganizing the Defense Dept.; he has merely put into effect the provisions already written into law.

The statutory authority of SecDef makes him:

—Head of an executive department.

—Principal assistant to the President on defense.

—The single person who is empowered to exercise direction, authority and control over all elements of DOD.

—The one responsible for operations of the unified and specified combat commands.

The vastly complicated job of the Defense Secretary is a dual one. He is responsible for the basic research, applied research and engineering, procurement and production for the weapons systems supplied to the armed forces. At the same time, he is responsible for the forces which use those weapons and the strategy and tactics they employ.

A legal opinion of the General Counsel has ruled that the Secretary of Defense is the Commander in Chief's deputy. Under this ruling, Secretary McNamara is regarded as the highest military officer of the department, a status that admittedly disturbs some elements of the military.



McNAMARA: Firm grasp on Pentagon.



GILPATRIC: DOD chief's alter ego.

But it is the role of the Secretary of Defense as a civilian administrator of weapons development and procurement that concerns the missile/space industry more than his military authority. This "business" side of DOD, made up of both military and civilian elements, supplies and supports the operational side.

To assist the Secretary in this function, he has the Defense Staff Offices, the Joint Chiefs of Staff, the military departments and military services within these departments and such other DOD agencies as the Secretary may decide to establish.

● **Special powers**—Congress recognized that in an organization as large as the Defense Dept., its chief executive needed management flexibility. Therefore, the Secretary of Defense has been given the authority to assign, reorganize, transfer or abolish any non-statutory functions in the department. In some cases, he even has the same powers in regard to the statutory functions.

This is accomplished by drafting a memorandum on his planned actions and filing it with the Congressional Armed Services Committees. If neither committee files a resolution of disapproval, the act becomes effective in 30 days. If one of the committees objects, then either house must find that the order interferes with the basic roles and missions laid out in the National Security Act and that the order is injurious. If this is not done, the Secretary's act takes effect in 40 days.

These powers are important to the industry because they could alter the military-industrial relationship when used. So could the two exceptions to these requirements, the cases where the Secretary can make statutory changes

without asking Congress:

—He may assign development and operation of any *new* weapon system to whatever service he pleases.

—He may assign supply and service activities common to more than one service to whichever service he desires.

Secretary McNamara thus has the broadest of powers under the 1947 National Security Act and its significant amendments of 1949 and 1958. By delegation his Deputy Secretary holds almost the same powers.

● **Alter ego**—One of the least understood relationships in the Office of the Secretary of Defense is that between Secretary McNamara and his junior partner, Deputy Secretary Roswell L. Gilpatric.

Traditionally, when a Defense Secretary takes office, he signs a paper passing wide powers to his deputy. This gives the deputy authority to do anything the Secretary can do—except delegate all of the Secretary's powers elsewhere.

Under McNamara, the Deputy Secretary has played a greater role than before—the two men are partners in the truest sense of the word. Gilpatric is empowered to exercise the powers of the Secretary whenever McNamara is out of town—but the relationship goes deeper than this legal authority.

Every paper which goes up for signature travels with a copy for both men. Either may sign it and, although each specializes in certain areas, it still is a guessing game for subordinates on occasion as to which signature will be affixed when the document is returned.

McNamara and Gilpatric each have two military assistants. These four officers work closely together to prevent contradictory or duplicating rulings by their superiors—though this would be a rare event since the Secretary and Deputy Secretary both have a fine mind for detail and hold very similar views. It is seldom that one is not aware of an act of the other or that their decisions would conflict.

Gilpatric is well chosen to serve in this role of alter ego to the Defense Secretary. He has a long record of Pentagon management experience and served on President-elect Kennedy's Defense reorganization committee.

● **"Whiz Kids"**—Probably the most controversial aspect of Secretary McNamara's reorganization of the Pentagon has been the emphasis he has placed on his civilian policy advisors, the so-called "Whiz Kids" whose job is to assist in policy formulation and to implement it once adopted.

The member of the OSD staff who probably wields more power over the missile/space industry than any other is the Director of Defense Research and Engineering, Dr. Harold Brown.

This office is one of the few in OSD covered by the statutory authority of the act which created the Dept. of Defense. The others, in addition to the Secretary himself and his deputy, include the three service secretaries, the comptroller and general counsel.

The DDR&E Director supervises all research and engineering activities in the Dept. of Defense. But what is not generally known is that Secretary McNamara could, if he desired, delegate line responsibility for all research and development—including the procurement functions now handled by the military services—to DDR&E. So far, he has chosen to keep DDR&E on a staff basis.

One reason for this is that neither DDR&E Director Harold Brown nor his predecessor, Dr. Herb York, has wanted the power implied in their statutory position. The fact that it exists in potential has been sufficient to serve its purpose when needed.

The Assistant Secretary of Defense (Comptroller) and the Assistant Secretary of Defense (Installations and Logistics) both play a major role of interest to industry in the OSD management structure.

Comptroller Charles Hitch, charged with the programming and auditing functions of the department, wields a strong financial stick over both future programs and proposals submitted on current programs.

Thomas Morris, in his I&L position, is principal staff assistant to McNamara on such things as materiel requirements and production planning and scheduling. He is in close, almost daily, contact with the three assistant service secretaries for logistics. Like other McNamara assistants, he plays a role both in making decisions and seeing that they are carried out.

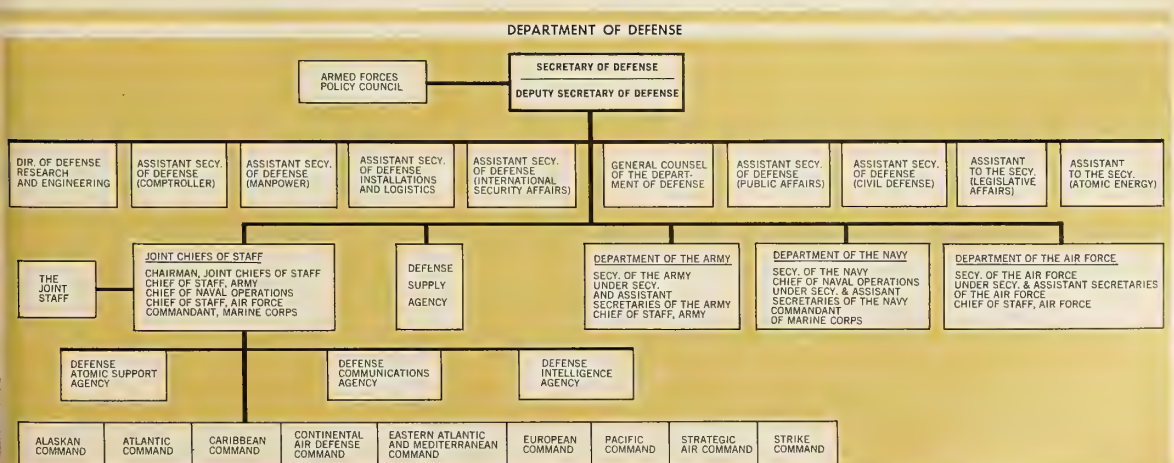
● **Rights of appeal**—In the event of conflict with any of McNamara's assistant secretaries in OSD, the service secretaries have the right of appeal to the Secretary himself, of course.

Nor does their right of appeal stop there. The service secretaries also may go directly to the President, as in the case of disagreement on the budget. Secretary of Air Force Eugene Zuckert protested to President Kennedy on both the RS-70 and *Skybolt* cutbacks.

Regardless of the authority in OSD, only the President can make decisions on some of the multibillion-dollar programs projected today. And he does.

One important trend under Secretary McNamara has been to "superagencies" to oversee the development and procurement of weapons systems, agencies such as Defense Communications Agency.

But these have been created in no particular pattern. They have been organized to meet management needs seen by the Secretary of Defense. Each has to be viewed individually to discover how it operates and what its responsibilities are. ■



FROM ASTROLABE TO APOLLO



Astrolabe (1st Century B.C.)—A Greek invention long used by Arabs and Europeans to provide astronomical sightings. The Astrolabe is a predecessor to today's sextant. (Cranbrook Institute of Science)

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ACCURACY, LOW COST, RAPID DEVELOPMENT, EARLY DELIVERY

The dream to navigate through space is as old as man, and today that dream is nearing reality. The capability to turn ideas into reality is found at AC. AC's ability to produce accurate systems in rapid time, at low cost with early delivery is now being applied to Guidance Systems for the USAF TITAN II and III, NASA's APOLLO Program and POLARIS inertial instruments, as well as providing Weapon System Integration and Bombing Navigational Systems for SAC aircraft.

AC welcomes the opportunity to assist you with its proven experience, facilities and manpower in system development, production and management.

APOLLO PROGRAM—AC will fabricate the inertial platform, with associated electronics, gyroscopes and ground support and checkout system. AC will also have responsibility for assembly and test of all navigation components.



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Hitch's Office Has New Significance

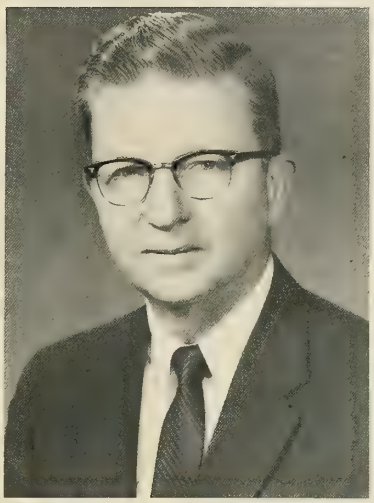
Five-year financial programming, assessment of systems costs and effectiveness added to office's budget functions

WHILE COMPTROLLERS have traditionally been supporting players in the management of government agencies, the present Department of Defense Comptroller's office is planted squarely in the middle of the decision-making process.

Under the McNamara concept of "planning—programming—budgeting," the processes of decision-making and budget-making are so integrated that the comptroller's office under Charles J. Hitch now has a dominant role in shaping DOD's progress.

The concept works like this: 1) planning is done by the Joint Chiefs of Staff and other inputs down the line in DOD; 2) the office of the Comptroller goes over these plans for costs, manpower, resources, etc., and, based on its findings, a continuing five-year program is drawn up; 3) each annual budget is based on the five-year program.

The concept differs from practices in other administrations, in that it ties planning and budgeting so closely together. In previous years, planning was done by the JCS and DOD agencies, and the budget came out somewhat independently from the Office of the Secretary of Defense. The services then had to take a look at how much they had to spend, and tailor their programs accordingly.



Comptroller Charles J. Hitch

With the new approach, each proposal gets a very hard look in the light of its five-year potential. Theoretically, it is no longer possible for a project to get its foot in the door by virtue of a low first-year budget.

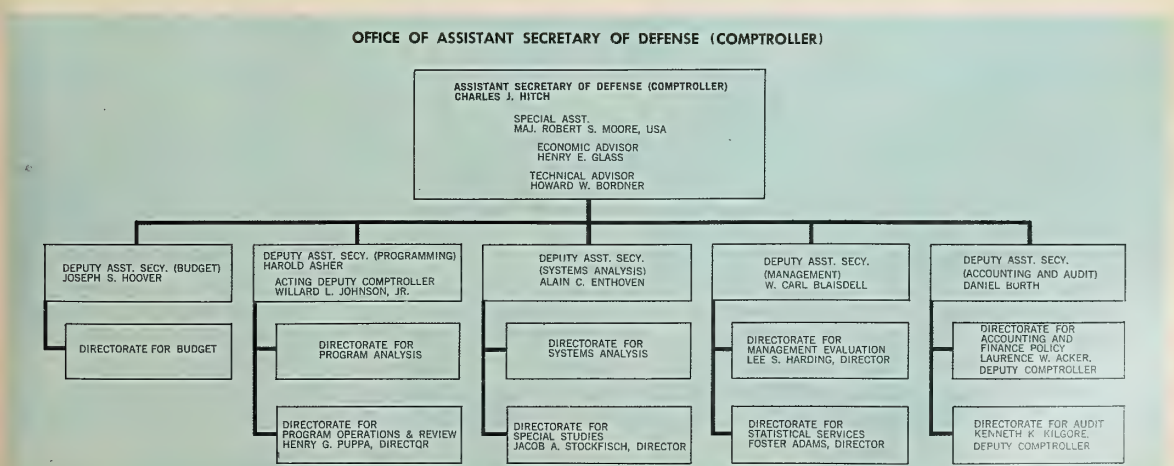
• **Functions**—The office has two new jobs—from which much of its power stems—under the McNamara reorganization, bringing the total number of functions to five:

—*Preparation of the budget*—Traditional role of the office. Besides drawing up the annual budgets, this includes apportionment of funds after Congressional appropriation and seeing that funds are held when appropriation is not firm.

—*Programming*—A new McNamara addition. The Comptroller's office is responsible for keeping a running five-year financial program, which is revised every month. Before this Administration, financial planning was largely limited to the one-year budget.

Introduced in 1961, the concept of this program has not been changed basically, since it is tied to the force structure of the Department of Defense and its major missions. However, the five-year costs have proved in practice to be somewhat overstated, and the Comptroller's office is now conducting a review of the last four years to see if it can get a more correct appraisal.

When a proposal involves research and development, technical evaluation



is done by the Deputy Director of Defense for Research and Development. However, the comptroller's office conducts a thorough cost analysis, and must figure out where the funds might come from.

If the proposal involves procurement and deployment in which manpower and large sums of money are involved, the comptroller's office also has a role. Besides analyzing cost, it decides what part of the Office of the Secretary of Defense should have primary action in evaluating the proposal, look at it to see if other services are affected, get comments from all involved offices and put these into a package for the decision of the Secretary of Defense.

Changes may be initiated in the five-year program by the services by drawing up a Program Change Proposal (PCP). The programming office, upon receiving a PCP, seeks the views of the Joint Chiefs of Staff and other interested offices—essentially the same parties who advised in drawing up the original program. PCP's may be originated at any time during the year and will receive consideration immediately.

This spring and summer, OSD is calling for special sessions to get as many program change proposals as possible—especially those affecting the force structure—out of the way before budget preparation begins. The sessions will begin with the Joint Chiefs of Staff presenting their views on the force structure in April; it is hoped that all major decisions may be made by Aug. 15.

A major change in the Pentagon that has prompted better planning in the Comptroller's office is the grouping of the entire Defense activity into nine major programs: Strategic Retaliatory Forces, Airlift and Sealift Forces, Reserve Forces, Ground Forces, General Purpose Forces, General Support, Research and Development, Civil Defense and the Military Assistance Program.

All facets of a program—manpower, equipment and facilities—are treated in a package under this new concept.

—*Systems analysis*—Another new comptroller function. Aim of this group is to improve the estimates of weapon systems costs and effectiveness which are submitted by the services. Although the services submit estimates prepared by such groups as Rand, IDA, and WSEG, officials say these tend to be optimistic in favor of the service. The comptroller's office at the same time presents alternative weapons systems or alternative ways of accomplishing the mission.

This group has the power to initiate its own independent systems analysis studies on weapons systems effectiveness, although most of its work is in trying to present the best cost and manpower estimates.

—*Accounting and auditing*—Principal responsibility of this section is to have accounting systems that insure that funds are being spent in conformity with the laws by which they are controlled. It also draws up procedures for the cost savings program, and has the audit function and general supervision of the military departments.

—*Management*—The statistical services group provides services to all parts of the Office of the Secretary of Defense.

Work done by the management section of the Comptroller's office often reaches beyond DOD levels. Data produced by this group are used by Secretary McNamara to make recommendations to the President when balance-of-payments enters the picture.

Four times a year this section submits a report—called the "gold budget"—to the Bureau of the Budget. It outlines estimates of what DOD will spend in foreign markets for the next three months, and reviews what the figures were for the previous period.

These figures then go to a cabinet committee consisting of the Secretary of State, Secretary of the Treasury, and Secretary of Defense to aid the committee in making decisions on military purchases in foreign markets and Military Assistance programs.

● **New objectives:** A number of new projects has been outlined for the Comptroller's office for this year:

Refine existing procedures—Several procedural improvements are being developed to clear up some remaining difficulties. They deal mostly with defining cost classifications and allocations.

Improve cost analysis—The Comptroller's office is primarily concerned with developing means for making rapid cost comparisons, and with improving techniques and data support for making special studies.

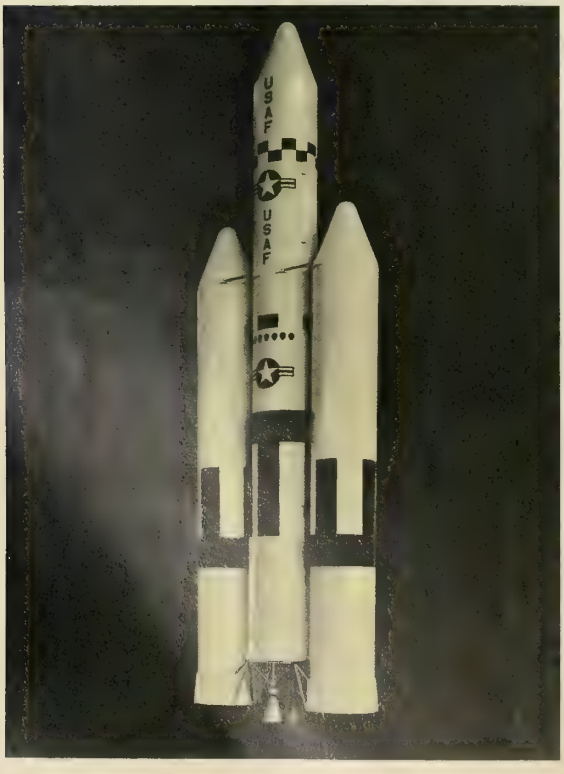
A number of sizable cost studies was completed last year with the aid of contractors, and these are to serve as patterns to develop costing capability.

Improve alignment of budgets and programs—Better coordination is still sought between program approval and funding control.

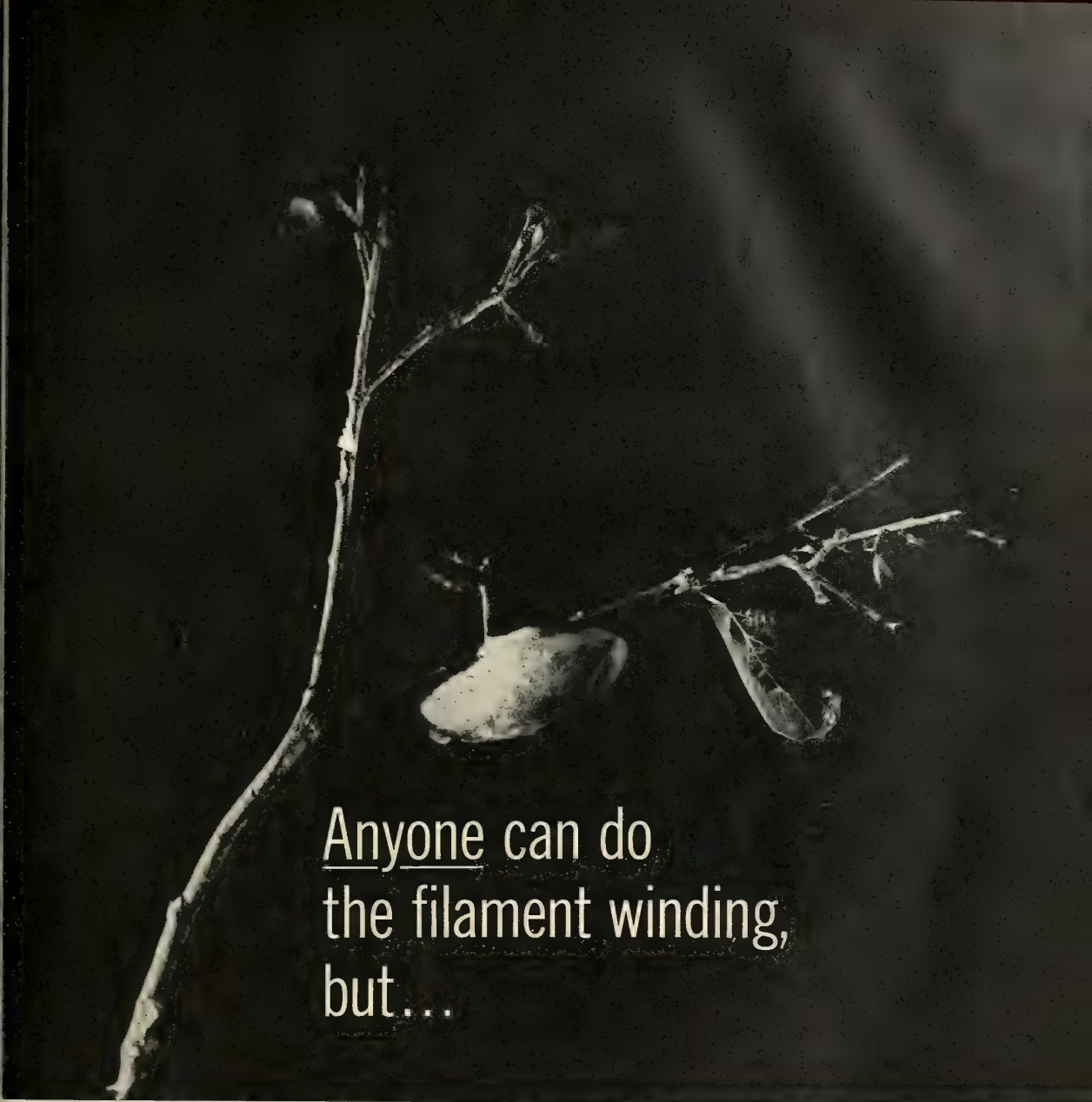
Accounting system improvements—Both programming and management improvements have been recommended.

Data-processing expansion — More automatic data-processing equipment probably will be needed for the current programming system.

Planning and controlling acquisition of resources—The most common reason for deviation from approved programs is failure to meet plans for acquiring resources. This year, a system will be devised to plan and control such acquisition. This will necessitate furnishing planning data and a financial plan. ■



MODEL of Martin Titan III Standard Space Launch System, first program to which DOD applied cost effectiveness study.



...IN ROCKET TECHNOLOGY, THE SECRET IS TO DEVELOP A METHOD OF OR SECURING TOGETHER LARGE FIBERGLASS CASING SEGMENTS TO PRODUCE HUGE BOOSTERS WITH MULTI-MEGAPOUND THRUSTS THAT CAN BE EASILY TRANSPORTED AND ASSEMBLED IN THE FIELD. UTC HAS DONE THIS. A METAL MECHANICAL JOINT PROVED HIGHLY SUCCESSFUL IN A TEST-FIRING OF THE FIRST SEGMENTED, SOLID PROPELLANT ROCKET MOTOR EMPLOYING A FIBERGLASS CASING. THE INHERENT ADVANTAGES OF EPOXY-BONDED FIBERGLASS CASINGS FOR LARGE BOOSTERS ARE SIGNIFICANT: ☐ LOW PRODUCTION COST AND REDUCED PRODUCTION LEAD TIME, BECAUSE DIFFICULT METAL CASING FABRICATION IS NOT REQUIRED. ☐ LIGHT WEIGHT, ANOTHER IMPROVEMENT OVER METAL CASINGS. ☐ HIGH STRENGTH-TO-WEIGHT RATIO. ☐ ON-SITE ASSEMBLY OF FIBERGLASS ROCKET MOTORS. ☐ IMMEDIATE DEVELOPMENT OF FIBERGLASS CASING SEGMENTS FOR ROCKET MOTORS 120″ IN DIAMETER AND LARGER. RELATED UTC CAPABILITIES INCLUDE FILAMENT-WOUND ABLATIVE-COOLED THRUST CHAMBERS, ROCKET MOTOR CASINGS IN ALL SIZES, NOZZLES. ANOTHER ADVANCE IN THE STATE-OF-THE-ART BY UTC.

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Brown Oversees All Military RDT&E

Director keeps programs under continuous review; ARPA and WSEG are functional arms of vast organization

ALL RESEARCH, development, test and engineering activities in the U.S. military establishment are supervised by Director of Defense Research and Engineering Dr. Harold Brown.

The Director's office reviews these programs continuously and exercises his authority to approve, disapprove, initiate, limit, transfer or cancel projects.

Key agencies in the directorate are the Advanced Research Projects Agency (ARPA) and the Weapon Systems Evaluation Group (WSEG).

Through the Assistant Secretary of Defense (Comptroller), the DDR&E Director has firm control over authorizations to obligate funds against approved programs. These controls are extremely precise and have a degree of built-in flexibility which allows the military departments to effectively execute the complex programs.

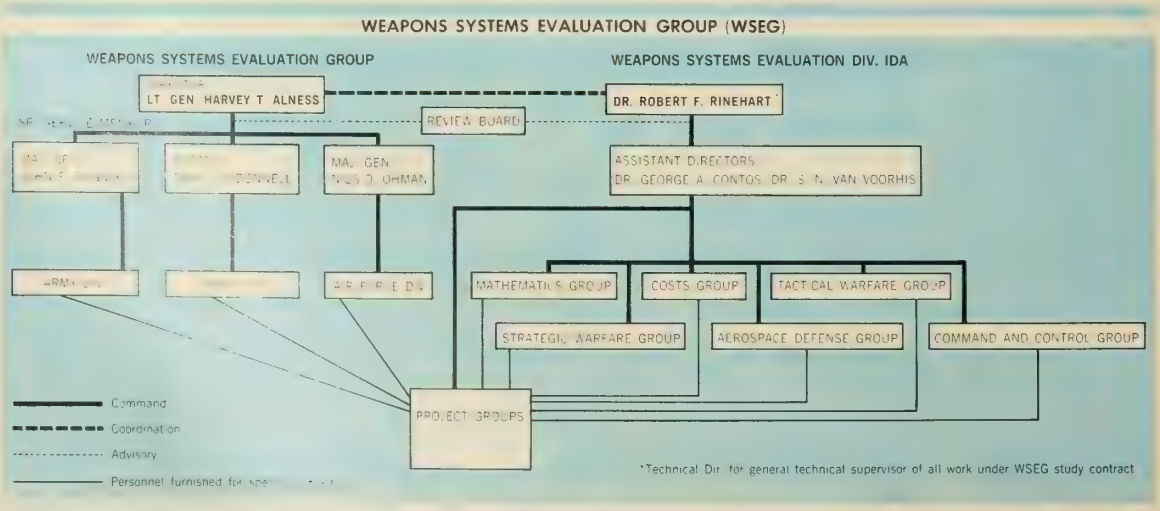
DDR&E has a personnel authorization of 252 in the Director's immediate office. This is in addition to ARPA and WSEG. There are 103 civilian professionals on this staff, each with specialized experience in some field of science or engineering.

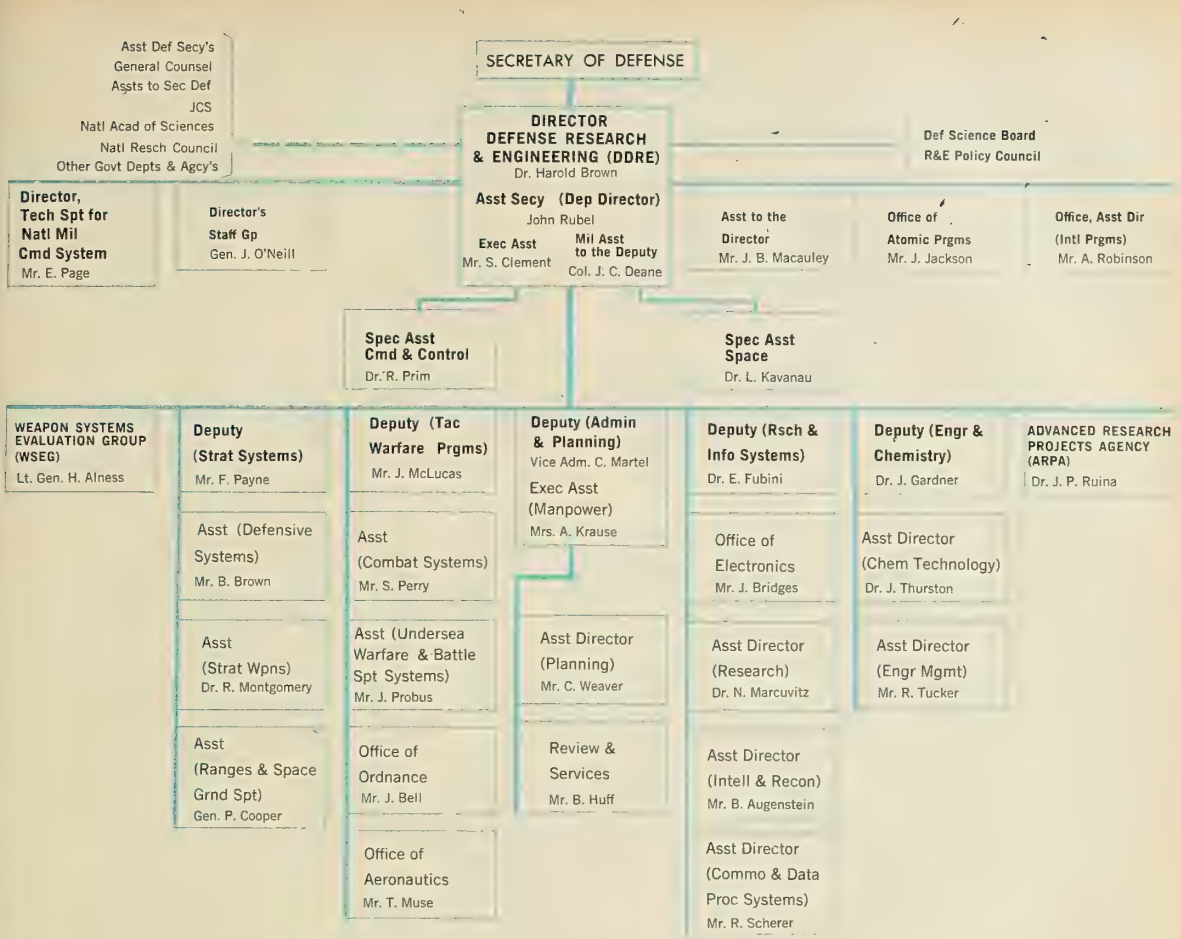
Forty-two professional military people on the Director's staff have specialized backgrounds in technical and operational experience.

• **Directorate breakdown**—The DDR&E staff is organized under five deputy directors, covering efforts in the general areas of Strategic Weapons, Tactical Warfare Programs, Administration and Management, Research and Engineering, and Chemistry.

The Strategic Systems Division covers defensive systems, strategic weapons and ranges, and space ground support. Tactical warfare problems include combat systems, undersea warfare and battle support systems, ordnance and aeronautics. The Research Division also handles information systems. Its broad areas include electronics, research, intelligence and reconnaissance, and communications and data-processing systems.

Chemical technology and engineer-





ing management are covered by the Deputy for Chemistry and Engineering. Manpower review, services and planning are handled by the Deputy for Administration and Planning.

These groups might well be termed planning units, styled to handle the fundamental problem areas inherent in the current defense situation. The functional groups are WSEG and ARPA. WSEG is administratively under the Director of DR&E and receives most of its business from the Joint Chiefs or the Secretary of Defense in terms of weapon systems analyses.

ARPA is an activity of the DDR&E office, reporting directly to the Director. Programs thought worthy of initial work but not clearly within the purview of a specific military department are pursued by ARPA. Programs of interest to two or more military departments also may be handled by ARPA, as are projects needing an "artificial" priority —those which must be pursued by an agency not subordinate to a specified military department.

Areas relating to space and command and control that cut across the fundamental problem concepts handled by the deputy directors are staffed by special assistants.

In addition, special staff office functions exist to give technical support for the National Military Command System and to cover international and atomic energy programs relating to research and development.

This organization concept approaches the whole RDT&E effort through six major categories—research, exploratory development, advanced development, engineering development, operational systems development and management and support.

—*Research*—Includes all efforts directed toward increasing the understanding of natural phenomena from which new ideas for military hardware may be generated.

—*Exploratory Development*—Represents that effort directly aimed at the solution of specific military problems short of major development projects.

—*Advanced Development*—Directs the building of test or experimental hardware to check out theory and engineering data prior to final engineering.

—*Engineering Development*—Covers the design and building of specific hardware which is destined for service use but not yet approved for procurement or operations.

—*Operational Systems Development*—Serves as the handmaiden of engineering development—RDT&E work is identical except that the projects here have been approved.

—*Management and Support*—Groups all the R&D efforts applied to support of installations or operations designed for general R&D use.

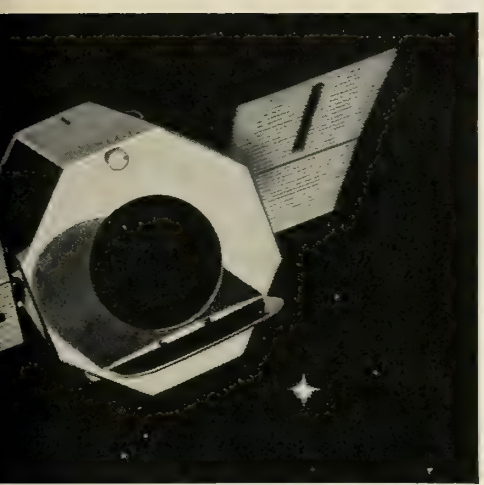
● **ARPA**—The Advanced Research Projects Agency is functionally organized. The program level now provides for area directors in chemistry, materials, remote area conflict, missile defense, nuclear test detection, and command/control and behavioral sciences.

(Continued on page 85)



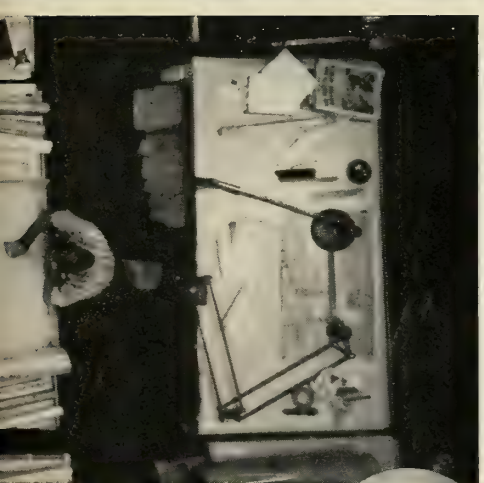
FACILITIES

Latest step in Grumman's long-range aerospace programming is construction of a new $5 million Aerospace Engineering Center, shown here in an architect's drawing. Along with the recently completed Electronics Systems Center and in-progress Research Center, this new complex of aerospace facilities will give Grumman the physical capabilities and resources to undertake major space system assignments.



EXPERIENCE

In the early 1950's, Grumman instituted a comprehensive, long-range program of space studies. Significant areas were hypersonics, reentry, capsule retrieval, orbital transfer and lunar vehicles. Major accomplishment to date is acquisition of the OAO (Orbiting Astronomical Observatory) contract for Goddard Space Flight Center (NASA), the Echo II canister assembly, and the Lunar Excursion Module (LEM) in connection with Project Apollo. More recent study contracts include the performance study for Lunar Logistics Systems and a new contract study in Lunar Astrodynamics. Against the background of 33 years' experience in solving the man-machine equation in aircraft and weapons systems, Grumman now offers a fully integrated space capability.



AND ESPECIALLY

PEOPLE

Grumman's most valuable asset is people: scientists, engineers, technicians and craftsmen. This work force provides an unbroken network of interlacing aerospace experience and skills. Over all is a management team with the uncommon knack of fitting man and machine together . . . of correlating large-scale programs simultaneously . . . of ensuring "total company" effort . . . of transforming advanced ideas into reality. The Grumman work force is by far the most stable in the industry.

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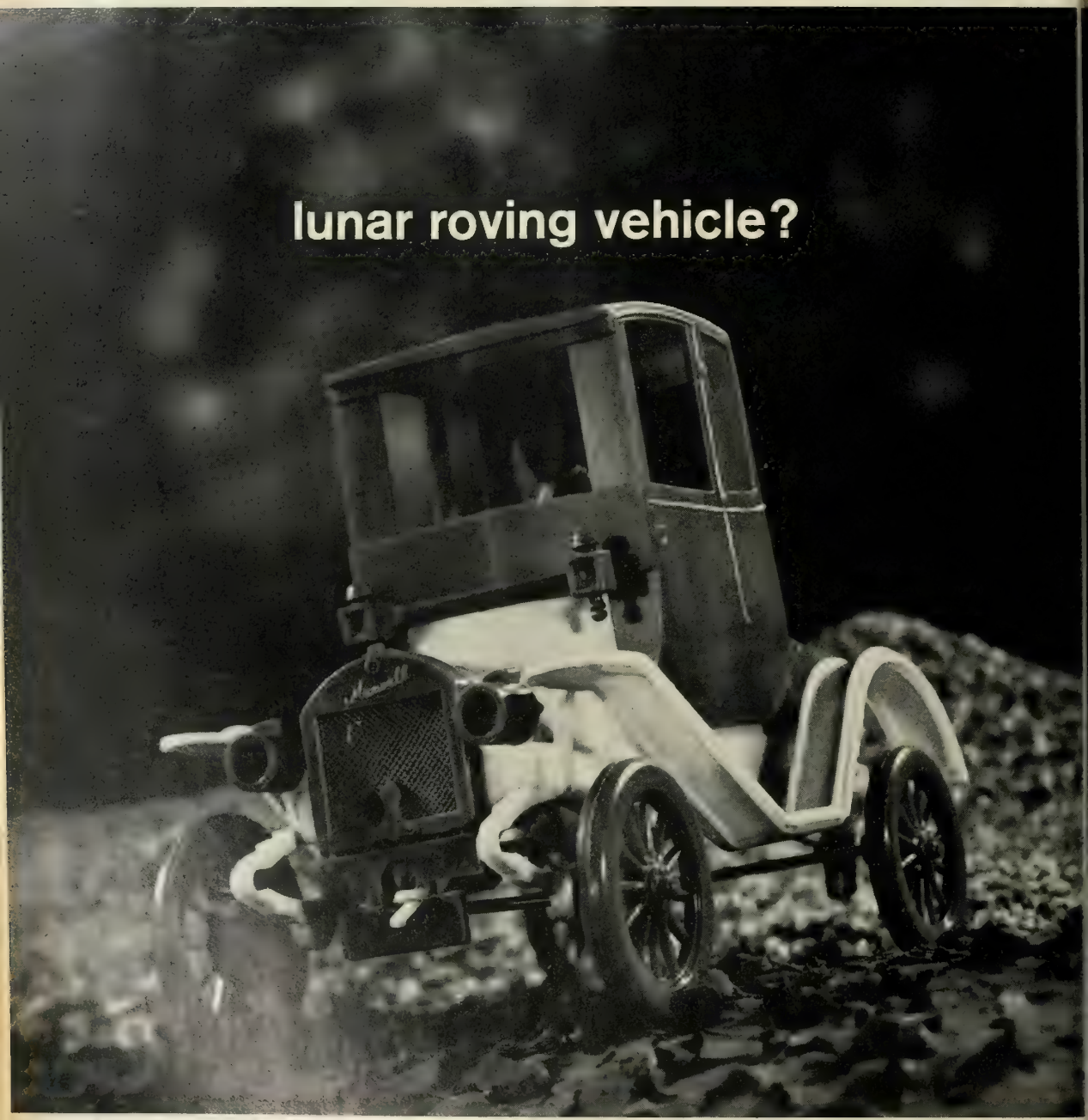
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Probably not. Yet no one knows for sure what it might look like, which is why studies are underway at AMF to define the vehicle that will meet man's needs when he arrives on the moon.

These advanced programs are directed at providing mobility for man during his early lunar explorations—and providing the know-how for the development of the specialized equipment to help man construct the first lunar base.

Other concurrent, across-the-spectrum aerospace projects at AMF are helping solve the problems of handling large boosters and payload packaging here on earth—as well as orbital grappling-attachment systems and mechanisms for soft-landing lunar payloads.



For more information on AMF Total Capability in aerospace systems and equipment, as well as in: **Aerospace Ground Equipment, Armament Systems, Field Installation** and Activation, **Hydraulic Power Packs, Hydrospace and ASW Systems, Mechanized Cargo Handling Systems, Missile Range Instrumentation,** Nuclear Systems and Equipment, **Radar Pedestals and Rotary Joints, Simulators and Trainers,** write for the new AMF brochure, "Ideas into Reality."

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(Continued from page 81)

ARPA is a line organization within DDR&E, and its director has the stature of a deputy director of DDR&E. While ARPA has built hardware, its outlook is entirely parochial—limited to research and development in the classical sense.

ARPA is probably at its maximum size right now, with a personnel complement of 75. Any new projects assigned to the group would mean some de-emphasis of current projects. But the functional setup usually has a slot for the many sub-areas. One ARPA spokesman says the system has progressed to the point where the agency can react quickly to new situations. This is especially true in its relationship with industry and universities, where the level of contact is highly informal and personal.

ARPA's size is a point of concern: if it became too small it could be rendered ineffective; if it should grow too big it might compete with the military departments.

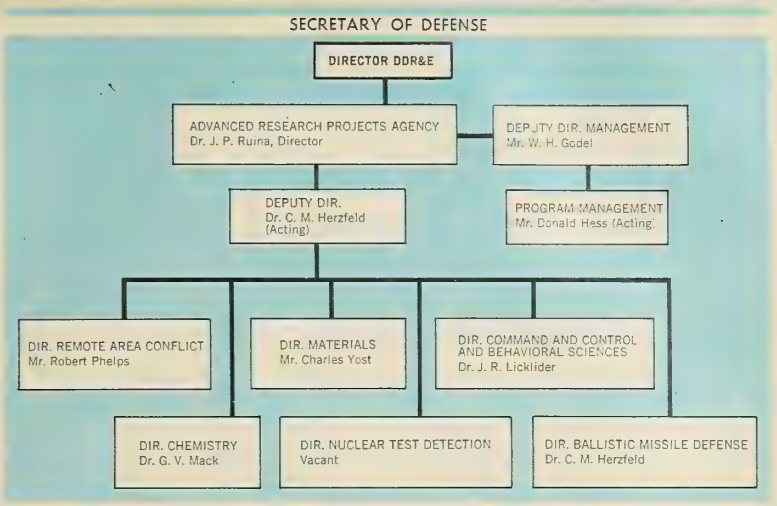
● **WSEG**—The Weapon Systems Evaluation Group was created in 1948 for the evaluation of arms by operations research methods. Dr. Vannevar Bush was the prime mover in setting up the organization. At the time, Bush was the head of the Defense Department's Research and Development Board, and James Forrestal was Secretary of Defense.

WSEG began operating in 1949. Its office was made up of military personnel plus civilian technical talent working under Civil Service regulations.

Then, as now, WSEG received its assignments from DOD and the Joint Chiefs of Staff. Administratively, however, WSEG has always reported to the R&DB or its successors—today, to DDR&E.

The original organization was altered sharply in 1955, when the civilian portion of WSEG was removed from Civil Service and made a contracted group with the Massachusetts Institute of Technology. This was an interim arrangement intended as a first step toward attracting university-type personnel to help solve WSEG's technical problems.

A year later, the Institute for Defense Analyses (IDA) was formed to give a broader base to WSEG's activities and to further increase the role of the academic world. IDA's founding organizations were California Institute of Technology, Case Institute of Technology, MIT, Stanford University and Tulane University. Later, the University of Chicago, Columbia University, the University of Michigan, Princeton University, the University of Illinois, and Pennsylvania State University joined the sponsoring membership (see p. 115).



A listing of the problems WSEG is concerned with includes, under a "General War" category, missiles, bombers, warning systems, communications and defense systems; under "Limited War:" tactical aircraft, tactical missiles, undersea warfare and logistics systems. In addition to these, WSEG looks into assigned questions on civil defense and arms control.

● **An objective approach**—The head of WSEG has two masters: DDR&E and JCS. He is also responsible—on a personal basis—to his individual service.

In operation, however, WSEG must be independent of any service bias in order to ensure objectivity in its reports. The organization must also be independent of any industry bias. A DOD spokesman told MISSILES AND ROCKETS that both of these criteria are admirably met. In fact, he said, "when an expert from industry is asked into the WSEG office to help out with a study in his field, he drops his company identity immediately. He is as apt to recommend against one of his company's efforts as he is to recommend for it, depending entirely on the merits of the case."

To remove any residual service bias that might creep in and also to assure a fresh approach to problems, the director of WSEG is changed about every three years and his successor is chosen from another service.

● **WSED in IDA**—WSEG does all of its outside contracting with IDA, although it is not required to do so. IDA, in turn, supplies the technical civilian scientists to WSEG through its Weapons Systems Evaluation Division (WSED)—headed by Dr. Robert F. Rinehart, professor of mathematics on leave from Case Institute of Technology.

Funded by WSEG at between $4 million and $4.5 million annually, WSED comprises about 40% of IDA. Its work is done under a continuing contract and on a task basis. This means that individual proposals are not put in by WSED; instead, each job is simply listed as a task under the overall contract. So far there has been no lack of tasks; the problem, in fact, is to get personnel sufficiently qualified to do the work at hand.

A DOD directive issued last August requires that the contributions made by WSED to a WSEG report must be clearly marked. This was recommended in the Bell report.

● **Organization**—The Weapons Systems Evaluation Group is composed of itself plus WSED. In mathematics, this would be an instance where a group contains itself as a subgroup. The reason is that the military—the WSEG subgroup—and the civilians—the WSED subgroup—work so closely together that it's difficult to list their combined efforts in any fashion other than as belonging to WSEG as a whole.

Strictly speaking, however, WSEG is made up of a military staff having WSED as a contract effort.

To get a tri-service view, three senior officers, each representing one of the services, assist the director of WSEG. Two of these are major generals and the third a rear admiral.

Each service is also represented by about 15 officers highly trained in some service-connected technical specialty. This might be *Polaris*, armor, reconnaissance or some other operational field. In this way, the approximately 75 scientists furnished by WSED can get valuable operational data close at hand. The military, in turn, also furnish technical inputs.

A further dividend is that data-gathering throughout the military is eased considerably when an officer has the assignment; one estimate puts the time saving at between 100% and 200% on the average project. ■



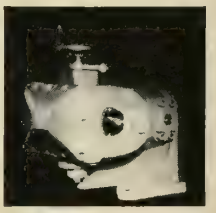
JPL tracking antenna does it with high accuracy hydraulic power for drive and control

Tracking objects thousands of miles deep in outer space calls for fast, smooth action and extraordinarily accurate control. The new 85-foot diameter receiving antenna pictured here is operated for NASA by the California Institute of Technology Jet Propulsion Laboratory.

The 30-ton parabola is driven and held "on target" by Denison hydraulic power. This 110-foot high receiving antenna—located at Goldstone Tracking Station, California—tracks and communicates with spacecraft in the U.S. space exploration program.

Each Denison component in this installation assures instantaneous response, reliability, troublefree service—all essentials for dependable ground support equipment.

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VARIABLE VOLUME AXIAL PISTON PUMPS (Denison Series 600) supply hydraulic power to main drive system of JPL tracking antenna.

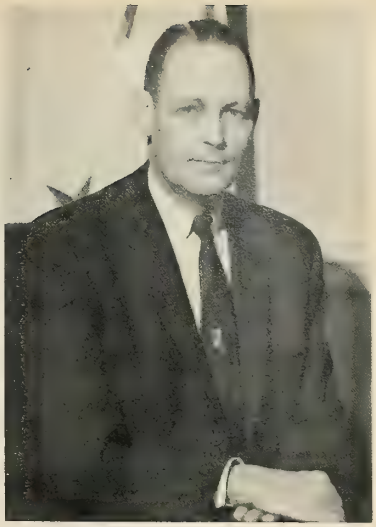
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Morris Operation Key To Most Defense Spending

Office develops overall procurement and logistics policies affecting military, Defense Supply Agency, and industry



Assistant Secretary Thomas D. Morris

KEY OFFICES in the entire procurement and logistics chain of command—from the Secretary of Defense down through the local military or DSA field activity—are the Pentagon chambers of Assistant Secretary of Defense (Installations & Logistics) Thomas D. Morris and his staff.

Morris is Secretary McNamara's chief advisor in these matters, concerning himself with both policy and the procedures by which it can be carried out. In this position, he is recognized not only as top procurement and logistics advisor, but as virtually the top policymaker in a vast empire which accounts for an estimated 60-75% of total DOD spending each year.

Within DOD, Morris, his deputies and staff are credited to a great degree for the large measure of success that McNamara's five-year DOD cost-reduction program has had in its first full year of operation.

Much of I&L's success, particularly in the procurement area, stems from Morris's extremely close personal relationships with the individual service secretaries charged with I&L functions. Recommendations flowing from his office to OSD are always the product of combined judgment, with virtually never any dissent.

Though much remains to be done, the early translation of the new McNamara goals into stated policy—with uniform procedures for moving them through DOD and into the directives which guide both military services and DSA procurement officers—has been extremely rapid and smooth.

• **Broad responsibilities**—As a functioning office, I&L is still quite new in its current configuration. Created in 1961 as a result of an earlier DOD study, the office combined into a single agency many of the duties formerly undertaken by the ASD's for Properties and for Supply and Logistics.

The result is an area of responsibility which ranges from military housing through planning assistance in ICBM-site land acquisition to responsibility (in cooperation with the military) for development and issuance of the highly-important Armed Forces Procurement Regulations (ASPR).

Though the span is great, and new efficiencies in family housing, for example, might mean more dollars for a weapon improvement, the major areas within I&L of immediate concern to the missile/space industry are the procurement and contracting policies (see page 32) generated in the office of the Deputy Assistant SecDef for Procurement, Graeme Bannerman, and in the guidance and goals supplied to the expanding Defense Supply Agency (see page 106) and to the individual service logistics chiefs.

Assistant Secretary of Defense (I&L) is the principal staff assistant to the SecDef in the functional fields of:

—Material requirements, production planning and scheduling;

—Acquisition, inventory management, storage, maintenance, distribution, movement and disposal of material, supplies, tools and equipment;

—Small business matters;

—Transportation, telecommunications, petroleum and other logistical services;

—Supply cataloguing, standardization and quality control;

—Commercial and industrial activities and facilities, including fixed industrial equipment;

—Military construction, including Reserve Forces facilities;

—Family housing and real estate and real property, including general purpose space.

Within these areas, his personal mandate includes:

—Recommending policies and guidance governing DOD planning and program development;

—Developing systems and standards for the administration and management of approved plans and programs;

—Reviewing programs of the military departments for carrying out approved policies;

—Evaluating the administration and management of approved policies and programs; and, in general,

—Recommending steps (including transfer, reassignment, abolition and consolidation of functions) which will provide more efficient DOD operation, eliminate unnecessary duplication, or contribute to military preparedness.

Morris is also coordinator of actions with the military departments and with other DOD agencies having related functions, and maintains liaison with other agencies outside DOD on supply and logistics matters.

To do all this, Morris has a staff of six deputy assistant secretaries—requirements and readiness planning, procurement, supply and services, production management, properties and installations, and family housing. In addition, he has an economic adjustment advisor—Chief of the Office of Economic Adjustment Robert E. Steadman—charged with studying and advising DOD on a broad range of economic impacts caused by defense buying and installation moves.

Also under Morris's wing, and receiving strong support within DOD, is the newly created Logistics Management Institute (see page 117). ■

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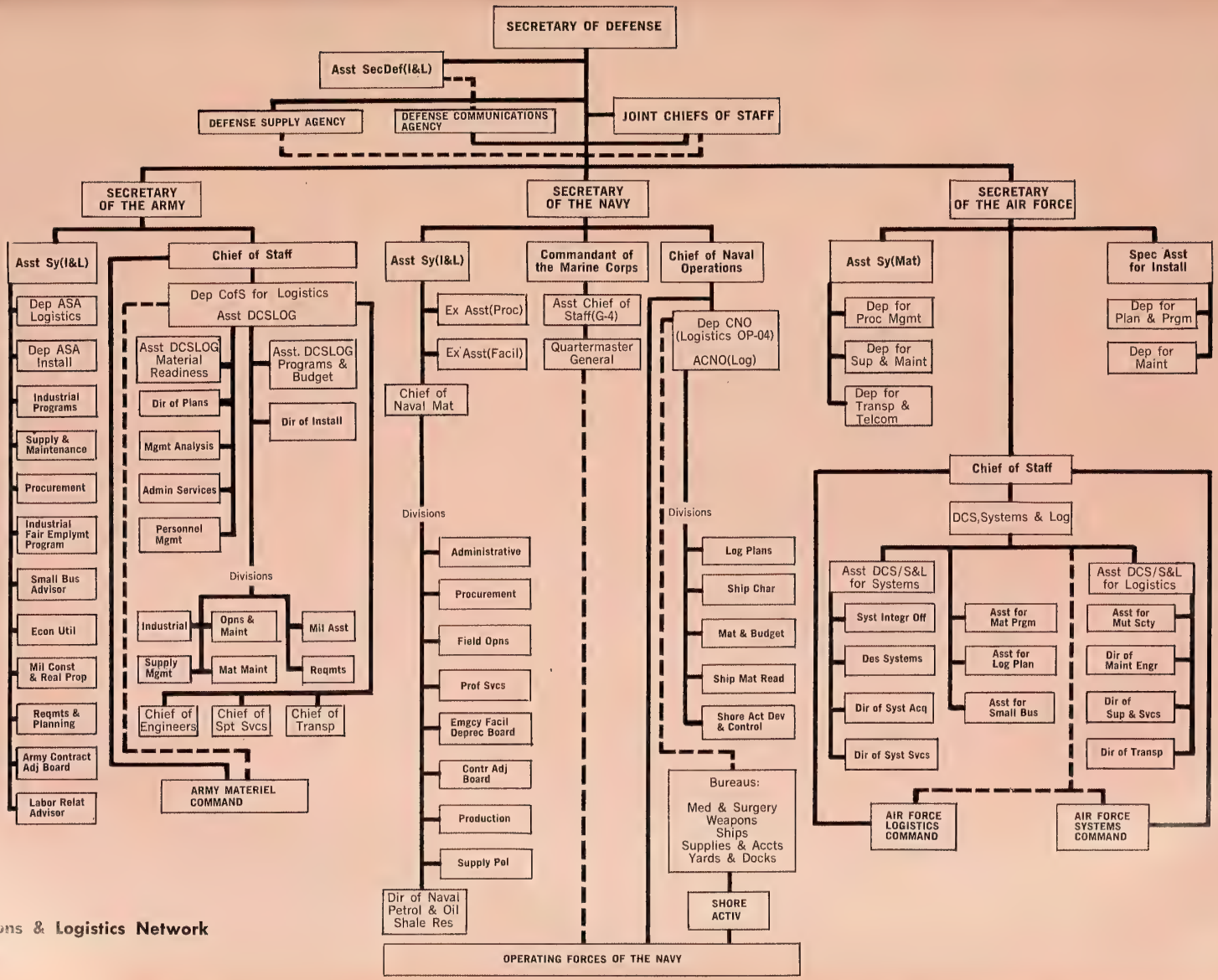
Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

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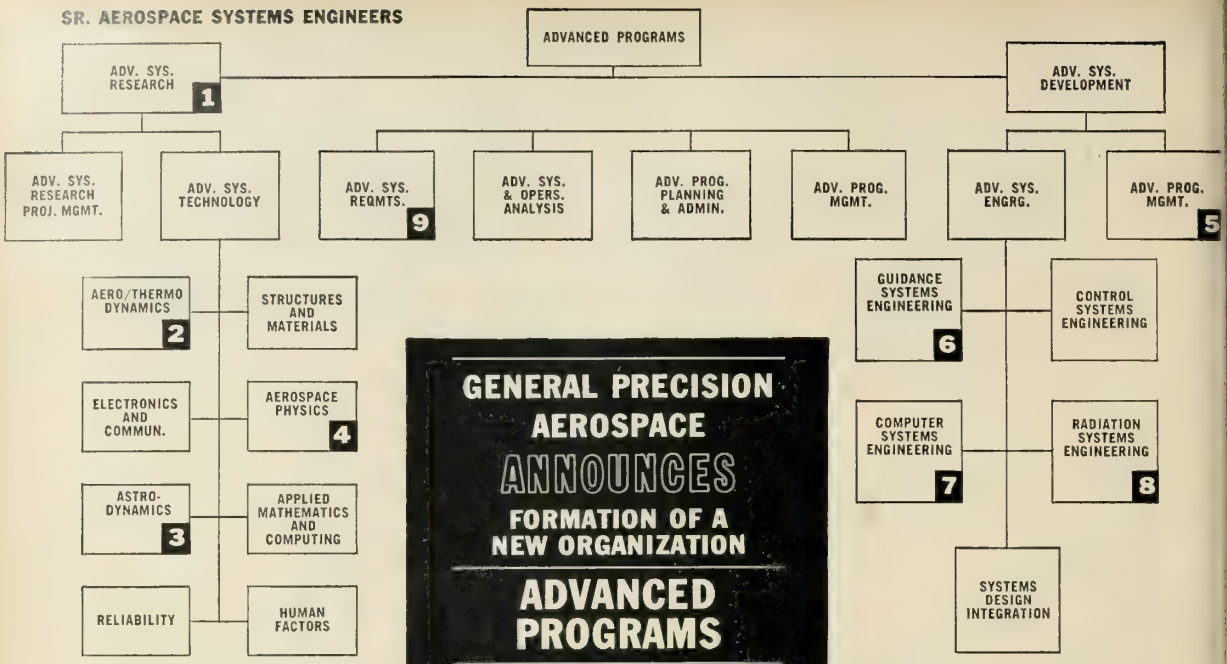
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GENERAL PRECISION AEROSPACE ANNOUNCES FORMATION OF A NEW ORGANIZATION

ADVANCED PROGRAMS

And the Creation of Many Key Positions

The primary responsibility of this new organization is to provide the advanced systems capabilities required for major new systems business. Broad diversification as well as growth is sought in the area where General Precision Aerospace already has established an outstanding competence: **guidance and control systems for aircraft, missile and space vehicles.** For example, in Advanced Programs, we are actively pursuing the development of systems whose **mission,** rather than function, is guidance and control. We are also developing a **total** capability for management and technical direction of **complete** missile and space vehicle system programs.

This effort is being based upon a comprehensive program of advanced systems research and advanced systems and technology development. The Table of Organization above indicates the scope of endeavor at Advanced Programs.

A PROGRESSIVE PATH TO ADVANCEMENT IS OFFERED THE DISCIPLINE-ORIENTED MAN

An engineer or scientist in Advanced Programs will spend as much time as required on the development of his technology as well as on its application. He will not be restricted to one program, in the manner of vertical organizations, but will contribute to many.

Insight into the diversity here may be gained from this partial list of major areas in which we are currently working: Advanced Aircraft Navigation & Guidance / Advanced Strategic Missile Guidance & Control / Maneuvering Re-Entry Vehicle Guidance & Control / Advanced Tactical Missile Systems / Advanced Space Vehicle Guidance & Control / Advanced Space Vehicle Systems.

Rendering technical services on systems projects as varied as these offers the staff member unique opportunities not only to keep pace with progress in his discipline but to contribute to advancement in the state-of-the-art.

PROGRAMMED STAFF EXPANSION

A personnel complement of over 100 engineers and scientists is contemplated for Advanced Programs in 1963

Strongly supported by the parent company, General Precision Aerospace, this new activity is part of a major program initiated in 1962 to meet the electronic systems needs of the next decade. Included in this program are new facilities: a Systems Engineering Building, for which ground was broken last fall; an excellently equipped Aerospace Research Center, which has just recently been completed.

ENGINEERS & SCIENTISTS ARE INVITED TO DISCUSS OPENINGS IN ANY OF THE FUNCTIONAL GROUPS ON THE ORGANIZATION CHART

1. PROGRAM MANAGERS — Advanced Systems Research
Manage team efforts related to systems research programs dealing with advanced concepts and future systems requirements, mission effectivity, and investigation of sub-system design criteria. Comprehensive experience required with major aerospace subsystems and demonstrated supervisory skills in managing major systems research programs.

2. SECTION HEAD & SENIOR STAFF ENGINEER — Aerothermodynamics
Conduct theoretical studies and research in aerodynamics and thermodynamics concerned with high Mach number vehicles, spacecraft, and re-entry bodies. Specific experience required in dynamics, thermodynamics, and aero-elastic problems associated with space vehicles and re-entry bodies.

3. SECTION HEAD & SENIOR STAFF ENGINEERS — Astrodynamics
Theoretical and experimental research and studies of space flight profiles and problems to determine design requirements, influence systems configurations and to identify future research efforts. Emphasis on guidance and control, navigation, attitude stabilization and related technologies.

4. SECTION HEAD & SENIOR STAFF ENGINEERS — Aerospace Physics
Research and study of the effects of space regimes and planetary environments on space vehicles and subsystems. Analysis of guidance trajectories. Experience required in nuclear physics, astronomy, or dynamics of planetary motion.

5. PROGRAM MANAGERS — Advanced Systems Development
Supervise and direct major proposal and development program efforts, utilizing modern management methods. Comprehensive systems engineering background required in complex electronic systems, guidance and control and communication sub-systems and the application of radar, stellar trackers, and digital computers in aerospace systems. Conduct preliminary design analysis and synthesis of future systems.

6. SENIOR SYSTEMS ENGINEERS — Guidance Systems
Engineering design and systems configuration of advanced aerospace guidance systems to meet future requirements. Experience in sophisticated systems analysis, hardware design and systems configurations required.

7. SENIOR SYSTEMS ENGINEERS — Computer Systems
Generate computer specifications and preliminary designs to meet computational and data processing requirements of future aerospace systems. Sophisticated and broad knowledge is required of logical organization and associated electronics.

8. SECTION HEADS & SENIOR SYSTEMS ENGINEERS — Radiating Systems
Preliminary design engineering and systems configuration of radiating subsystems to contend with hostile environments such as cosmic and nuclear radiation, temperature and pressure extremes, solar flares, and meteorites.

9. SENIOR STAFF ENGINEERS — Advanced Systems Requirements
Systems engineering analysis of new concepts and novel designs of aerospace systems to identify technology and design engineering requirements. Translate customer requirements into systems design criteria. Thorough knowledge of weapons systems design, trade-offs, and optimization techniques required with emphasis on guidance and control and related technical areas.

Additional engineering openings elsewhere in Aerospace Group.

Write in confidence to Mr. Paul Kull, Dept. 13C

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JCS Shape Future Weapon Concepts

Not formally in on contractor selection, the Chiefs still affect the decisions—and this role is growing under Taylor

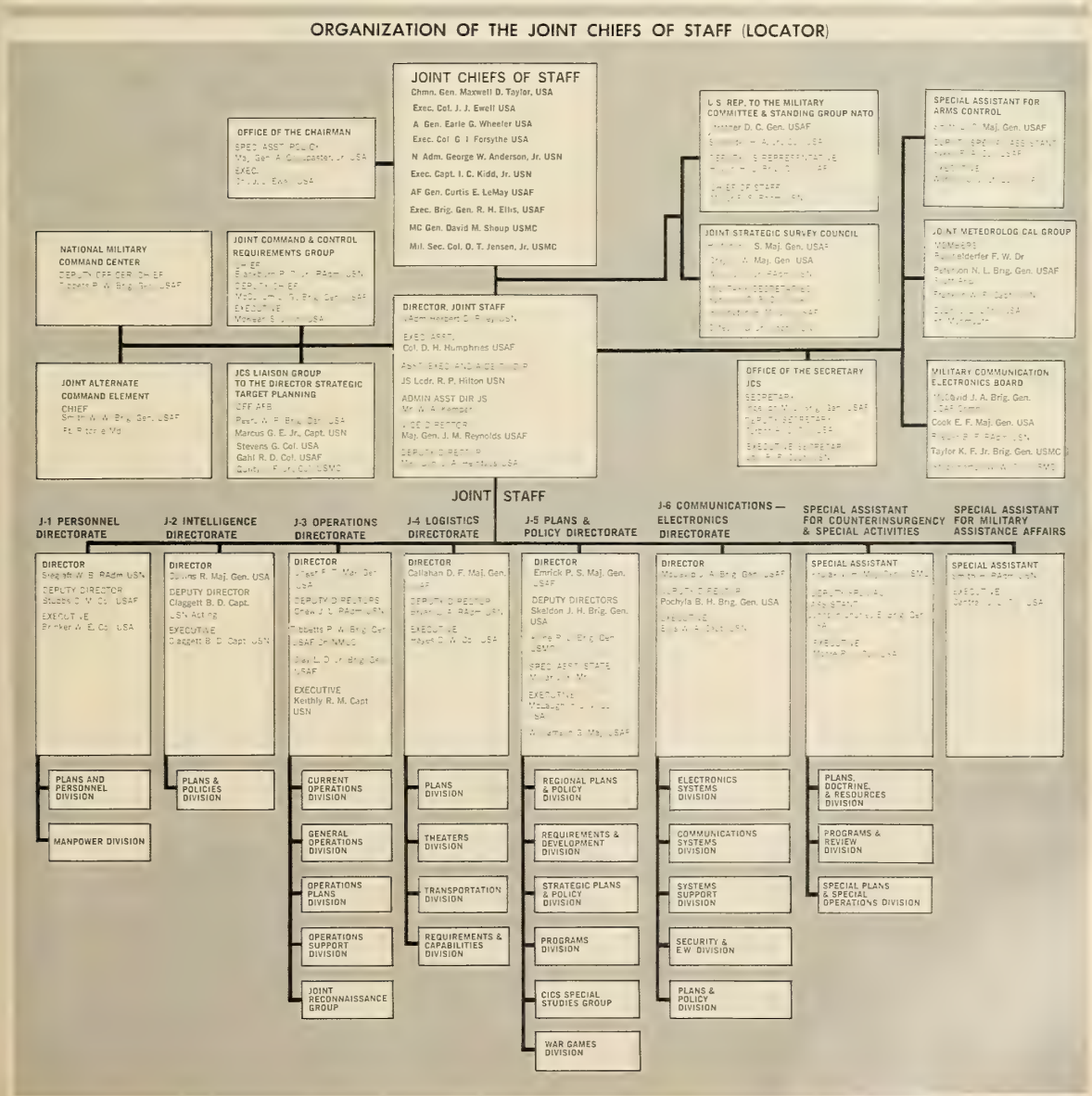
THE JOINT CHIEFS OF STAFF have a great deal to say about the types and quantities of the weapon systems purchased by the Dept. of Defense—they have very little to say about what contractors build those weapon systems.

The deliberations and pronouncements of the Joint Chiefs provide industry in general, and industrial advanced planners in particular, with strong clues as to the future course of DOD procurement.

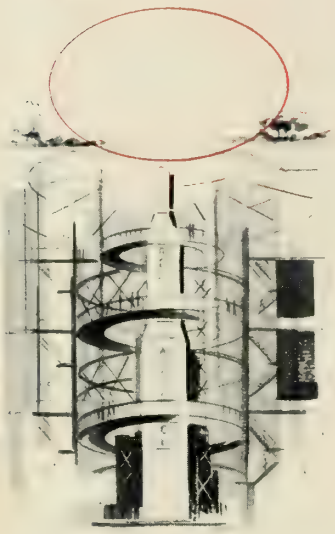
But the Joint Chiefs play no formal role in evaluating the bids of missile space contractors.

"The Joint Chiefs do not make decisions on hardware, but on concepts," says a top staff officer. "We don't let any contracts."

As the chief military advisers to the Secretary of Defense and the President, the JCS serve in a dual capacity. They are responsible for the strategic direction of the armed forces, including the direction of operations carried out by commanders of the unified and specified commands. But in addition to this opera-



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JOINT CHIEFS in meeting. From left to right: Gen. Earle G. Wheeler, Army Chief of Staff; Gen. Curtis E. LeMay, Air Force Chief of Staff; Gen. Maxwell D. Taylor, USA, Chairman of the Joint Chiefs; Adm. George W. Anderson, Jr., Chief of Naval Operations; and Gen. David M. Shoup, Commandant of the Marine Corps.

tional role, they also serve an administrative function in assisting the Secretary of Defense in establishing the requirements for the weapons to be used by the armed forces.

It is in this latter capacity that their work is of most interest to the missile/space industry. The Joint Chiefs are not only charged with drawing up military requirements and force levels, but they also assist the Secretary in research and engineering matters by making recommendations on new weapons.

● **A new chief**—With the advent last fall of Gen. Maxwell D. Taylor as JCS Chairman, the Joint Chiefs were drawn even closer into the decision-making process on the weapons systems DOD procures or cancels.

Gen. Taylor is one of President Kennedy's close advisers. He brought part of his White House staff with him to JCS when he left his post as special military advisor to the Kennedy Administration. Others of the Taylor staff remained in the White House family. The result is an extremely close liaison between the Joint Chiefs and the White House.

Suggestions that Secretary of Defense McNamara is engaged in downgrading and by-passing the Joint Chiefs appear somewhat ridiculous when viewed in this light. Military input at this level probably is stronger than ever.

President Kennedy's relationship with JCS is a working relationship.

"It's informal and that's the way the President wants it," comments a high-level member of JCS.

It is not uncommon for a colonel or a naval captain of the Joint Staff to be called to 1600 Pennsylvania Avenue to discuss a particular program with the President. Members of the Joint Staff are experienced not only in staff work but in operations and combat. They are specialists in various military fields. Their job is not to make decisions on weapons systems but to provide military advice to those who must make the decisions.

"We are a staff working for a civilian Secretary of Defense and the President," says a staff officer. "The decisions are made up there."

There is little direct formal contact between the Joint Chiefs and industry—by JCS preference, since their concern is with detailed requirements but not hardware. Industry inputs can, at times, reach the JCS through such avenues as Weapons Systems Evaluation Group studies (see p. 55) or through personal contact in their roles as service chiefs.

Under the McNamara approach, requirements these days usually are generated in the Directorate of Research and Engineering and passed down to JCS for study, rather than the other way around.

The services themselves still can generate requirements and pass them up through JCS as in the past. This does happen on occasion but a JCS spokesman estimates that fully three-fourths of the studies today are generated in the "think factories" of the Office of the Secretary of Defense.

Recommendations on weapons systems or applications of weapons systems can also originate, of course, at the Joint Staff level as well as in DDR&E and the individual military services.

● **Travels of a paper**—No matter where such a paper originates, it starts its formal travels through the JCS organization with assignment to an "action officer," usually of the rank of colonel or naval captain.

This officer goes fully into the proj-

ect and draws up his recommendations in a document typed on white onion-skin paper. This flimsy is scattered throughout JCS and the services to anyone who might be concerned with the program. This is dubbed informally in JCS as the "flimsy stage."

Recommendations made to the action officer may or may not be included in the document which he then draws up. This is passed to his division chief and on to the two-star officer in command of the directorate.

At this point, the paper on which the study is typed changes color and it becomes a "Buff Paper."

This paper is circulated at the two-star level in the services and to the directors of other parts of the Joint Staff. If there is general agreement on the recommendations, the study then "turns green." It is printed on green paper for action by the Joint Chiefs themselves. In the event of disagreement, a planning meeting may be called to settle differences. But an estimated 70% of the JCS papers pass on to the Joint Chiefs without this necessity.

The paper may take one of several courses at the Joint Chiefs' level. If it is a routine matter and no one raises an objection within seven days, it can become automatically an act of the Joint Chiefs. Deputies for the Joint Chiefs also are empowered to act for the Chiefs on certain matters.

● **The Chiefs meet**—The Joint Chiefs normally meet two or three times a week. The agenda placed before them usually has been thoroughly screened by the above process or by less formal telephone votes.

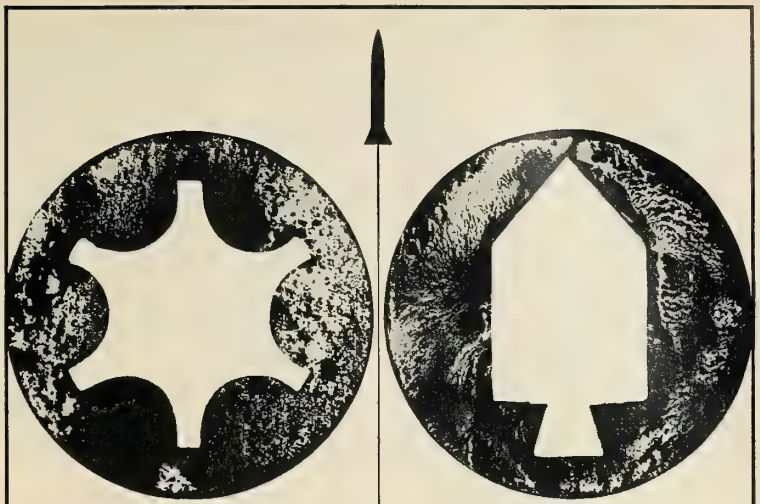
After action by the Chiefs on a paper, the Secretary of the JCS publishes it. It then goes to the Secretary of Defense as a formal recommendation of the Joint Chiefs of Staff.

In this manner, the nation's military chiefs wield their most direct influence on the nature of the weapons systems which DOD procures.

Since the JCS are military advisers to the President as well as to the Secretary of Defense, they are free to take any objections on the Secretary's decisions directly to the President, thus exercising a further influence on the nation's military decisions.

This is not merely a formal access to President Kennedy. It is used frequently. Air Force Chief of Staff Curtis LeMay, for example, protested bitterly to the President on Secretary McNamara's *Skybolt* decision.

The result, in this case, is well-known. But the overall record is much better. The majority of JCS recommendations are accepted by the OSD civilians upstairs and eventually have their effect on the hardware to be procured from industry. ■



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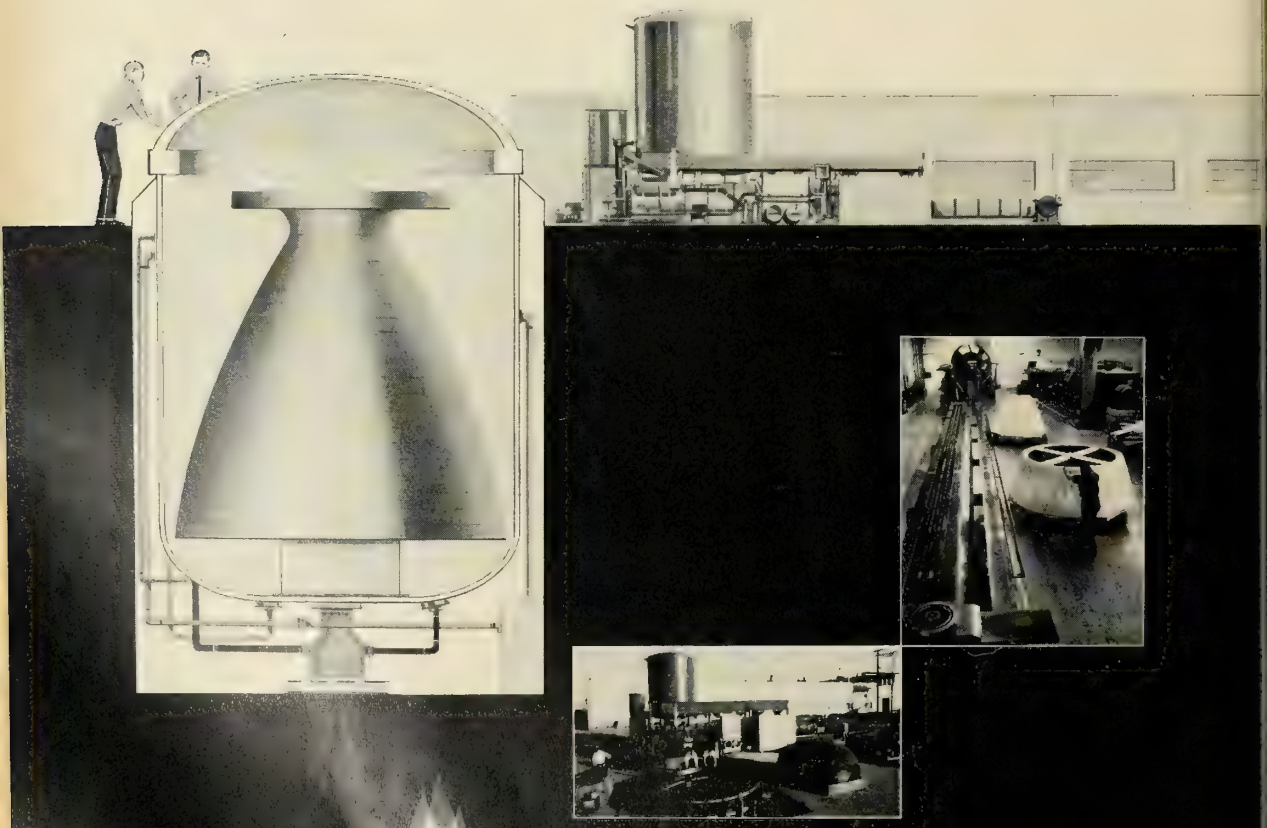
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Army Secretary Cyrus Vance



Navy Secretary Fred Korth



Air Force Secretary Eugene Zuckert

DOD / *service secretaries*

Centralization Forces Reorganization

Responsibilities have shifted from that of decision maker to manager and advocate of individual service requirements

CENTRALIZATION of power in the Office of Secretary of Defense is forcing sweeping changes in the organization and responsibilities of the three civilian secretaries who head the Army, Navy and Air Force Departments.

All three—Secretary of the Navy Fred Korth, Secretary of the Air Force Eugene Zuckert and Secretary of the Army Cyrus Vance—are revamping their operations to get them in tune with new DOD methods.

Among the major changes:

- A reorganization of the Navy is imminent. It is expected to streamline the R&D chain of command by having the Navy bureaus report directly to the Navy Chief of Staff rather than the civilian secretariat.
- The Air Force is setting up a brain trust in the office of Deputy Chief of Staff Lt. Gen. James Ferguson. It hopes it can thus match the technical competence of the office of the Director, Defense Research and Engineering—and can better defend Air Force programs.
- The responsibilities of the assistant secretaries of the Army are being revised. The objective—to obtain better coordination and cooperation in the R&D area.

In terms of the service secretaries, the new, all-powerful OSD has also forced a major revision—a secretary is no longer a decision-maker, but rather a manager and advocate of service requirements.

While the service secretaries still make major decisions within their departments, DOD has clear jurisdiction over program approval and the establishment of major policy for weapon systems, budgets and procurement.

For example, a new R&D program in any of the military services with a cost of over $2 million must be approved by Dr. Harold Brown, Director of Defense Research and Engineering. Any five-year program package with an annual cost of $10 million or more, or a total cost of $25 million, must also be approved by Dr. Brown (see p. 80).

In the budget area, where OSD has complete statute authority, separate approval for spending must be obtained by the service even after the program package has been approved by DDR&E.

OSD also sharply influences military procurement. Once OSD approval of the five-year program package and budget has been obtained, a new R&D project moves to the program definition phase.

Here the competition to select a contractor is conducted and final performance specifications are set. Once again, OSD approval must be obtained before the go-ahead can be given.

The freedom of action of the service secretaries is also curtailed in a reprogramming of budget funds approved by DOD and Congress.

For example, they have the final word only on reprogramming actions below $2 million. From $2 million to $10 million, the approval of Dr. Brown is required. Anything above $10 million requires the signature of McNamara or Deputy Defense Secretary Roswell Gilpatric.

Nevertheless, the service secretaries still have great influence. Although the major decisions in R&D projects, budgets, and procurement rest with OSD, for the most part, these are decisions by "exception" only. In a great majority of cases, the recommendation of the service secretary and the military department involved is accepted by OSD.

- **Role of service secretary**—Despite the centralization of power within OSD, the job of the service secretary is a tremendous one.

Each heads a department which spends more money in one year than any other single Federal agency outside the military.

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Within the DOD structure, the job of a service secretary is best characterized as the functional leadership of a "division" of which DOD is the active "holding company."

Within that scope, he has three major functions:

—*Advocate*—He is responsible for submitting programs to DOD which will meet the requirements set forth by the military head of the service.

Once such a requirement is received from the military chief of staff, the program is reviewed by the secretary's chief assistants for R&D and financial management. The secretary decides if it is feasible. If the program is rejected by DOD officials, the secretary can appeal the decision to Secretary McNamara and, if he feels justified, to the White House itself.

—*Manager*—Once a program has been approved, he is in complete charge of its management from initiation to completion. Involved are hundreds of decisions ranging from contract management, scheduling and technical changes desired by the military chiefs.

—*Budgetary*—The service secretary—together with the comptroller of the service and his assistant secretary for financial management—sets up a list of priorities for the military service. This is then coordinated with OSD. When DOD rejects certain budget requests, the decision as to which one the service will fight for is made by the service secretary.

One of the most important tasks of the service secretaries is to prepare their staffs—both military and civilian—for the searching questioning of their military requirements by OSD. This requires not only special efforts to insure that each R&D or procurement proposal is feasible, from a technical as well as a funding viewpoint, but also that the staff be so organized that it is geared for the best possible coordination and cooperation with OSD operations, as well as the best possible management of programs within the guidelines laid down by DOD.

Details of how each of the service secretaries is trying to achieve those aims and a breakdown of their chief assistants follow.

AIR FORCE

AIR FORCE programs have been hardest hit by negative decisions of OSD. Cancellation of the *Skybolt* missile is the most publicized, but several other missile/space programs have been cut back or reoriented after review at OSD level.

Because of the Air Force drive to get a military mission in space, it is making a concerted effort to develop the type of organization which will be qualified to present its arguments in the best light and, at the same time, find the necessary answers to counter OSD questioning of the technical and cost aspects of its program.

The major step has been the attempt by Secretary Zuckert to develop a brain trust in the office of the Deputy Chief of Staff for Research and Development. From now on, the office directed by Lt. Gen. Ferguson will be responsible for management of all new AF R&D programs.

It will also have complete staff responsibility for completing AF requirements for DOD's program package plans.

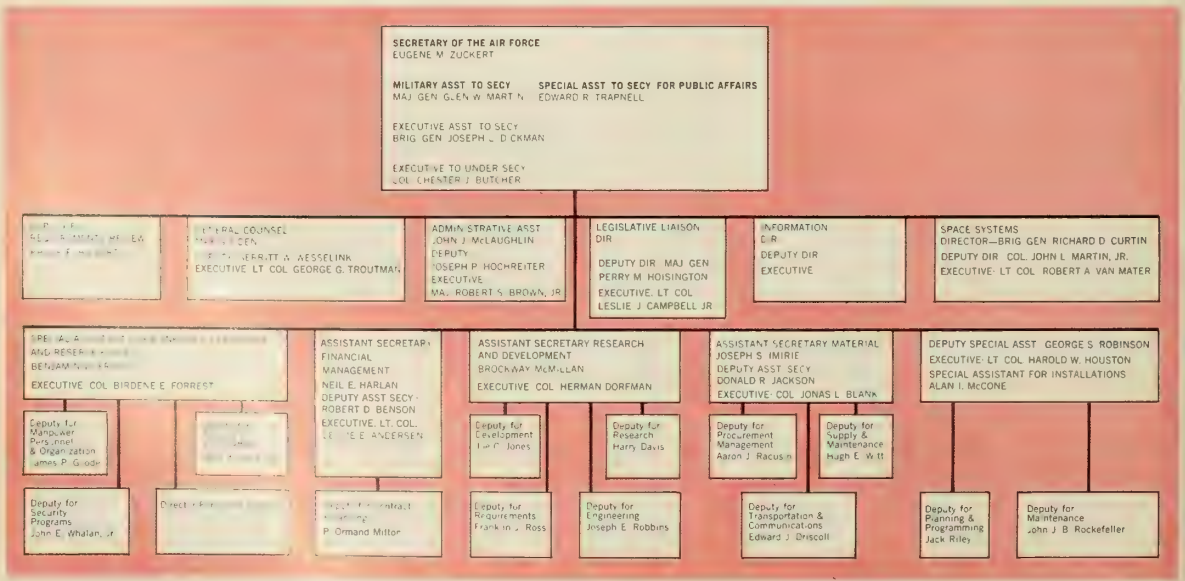
Previously, once a system was ready to be managed it was placed under the office of the Deputy Chief of Staff for Systems and Logistics. Often, it was just at that point that the programs came under heaviest fire from disenchanted officials at the DOD level. Thus, when Dr. Brown questioned an AF program there was no central office which handled R&D. The Air Force hopes that by centralizing its R&D effort in Ferguson's shop, it will be able to get better coordination with OSD, and also be able to develop the expertise to argue effectively for its programs.

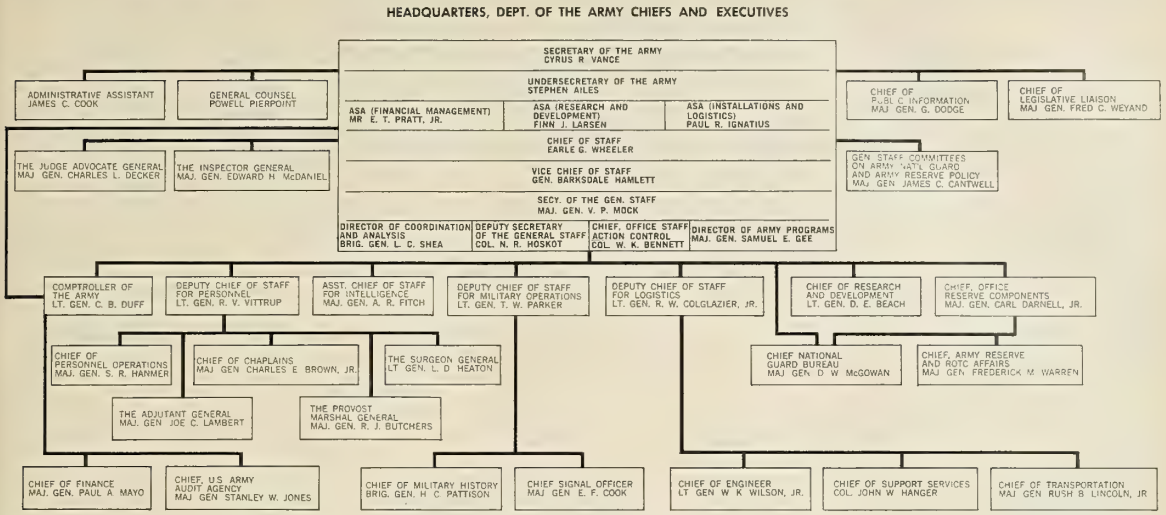
The Air Force expects to finish most of the reorganization by July, 1963. It currently is making final decisions as to exactly which programs will be placed under the DCS/R&D.

Several programs originally under DCS/S&L have already come under the DCS/R&D. These include Missile Defense Alarm System, *Dyna-Soar*, DOD communications systems and several booster programs.

- **Realignment**—The new organization of the R&D shop includes:

—*Assistant for Nuclear Energy*—





Will handle all research and development activities pertaining to USAF nuclear energy developments.

—Directorate of Advanced Engineering—Will include responsibility for space systems, missile and booster systems, and advanced technology in electronics and astronautics.

—Directorate of Science and Technology—Will cover the spectrum of basic and applied research in the scientific disciplines such as mechanics, propulsion, and electronics.

—Directorate of Development and Planning—Will be responsible for developments in space, astronautics, foreign development planning and development policy.

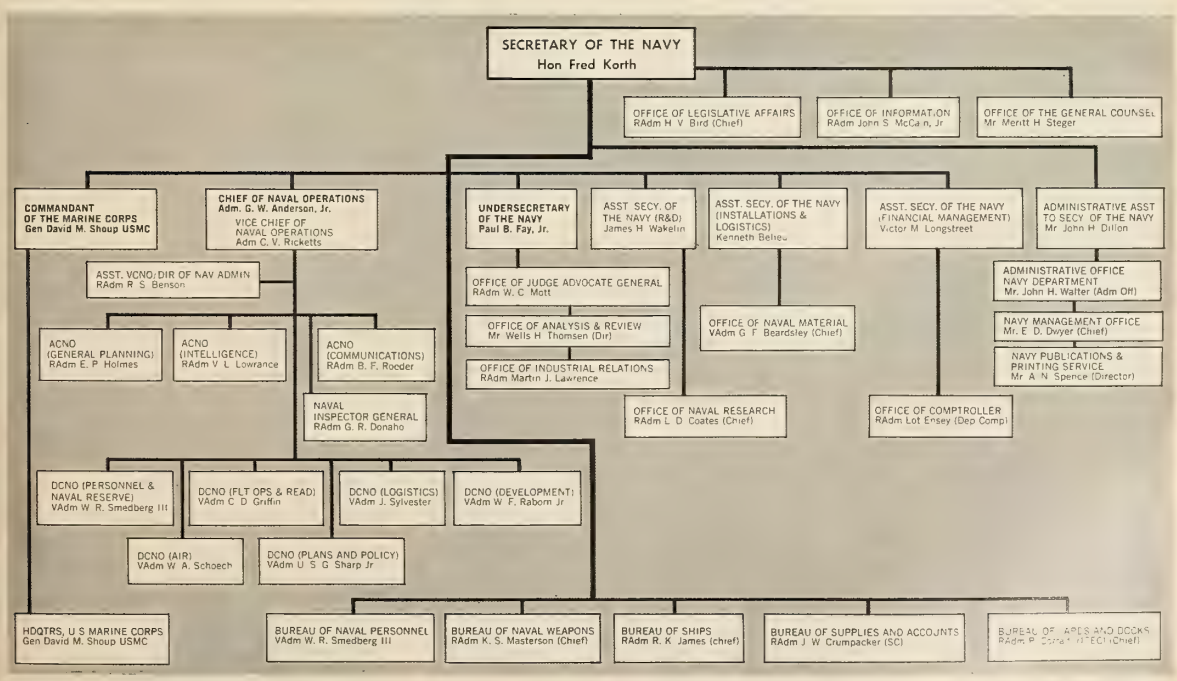
Zuckert—because of the immense R&D effort which is the AF's life blood—has also started a move to bring its requirements in the various phases of R&D more in line with those of the other services. He has also added two special deputies to his personnel staff.

One, Philip H. Hilbert, serves as the deputy for requirements review. He is responsible for analysis and review of requirements and the plans and programs from which they derive.

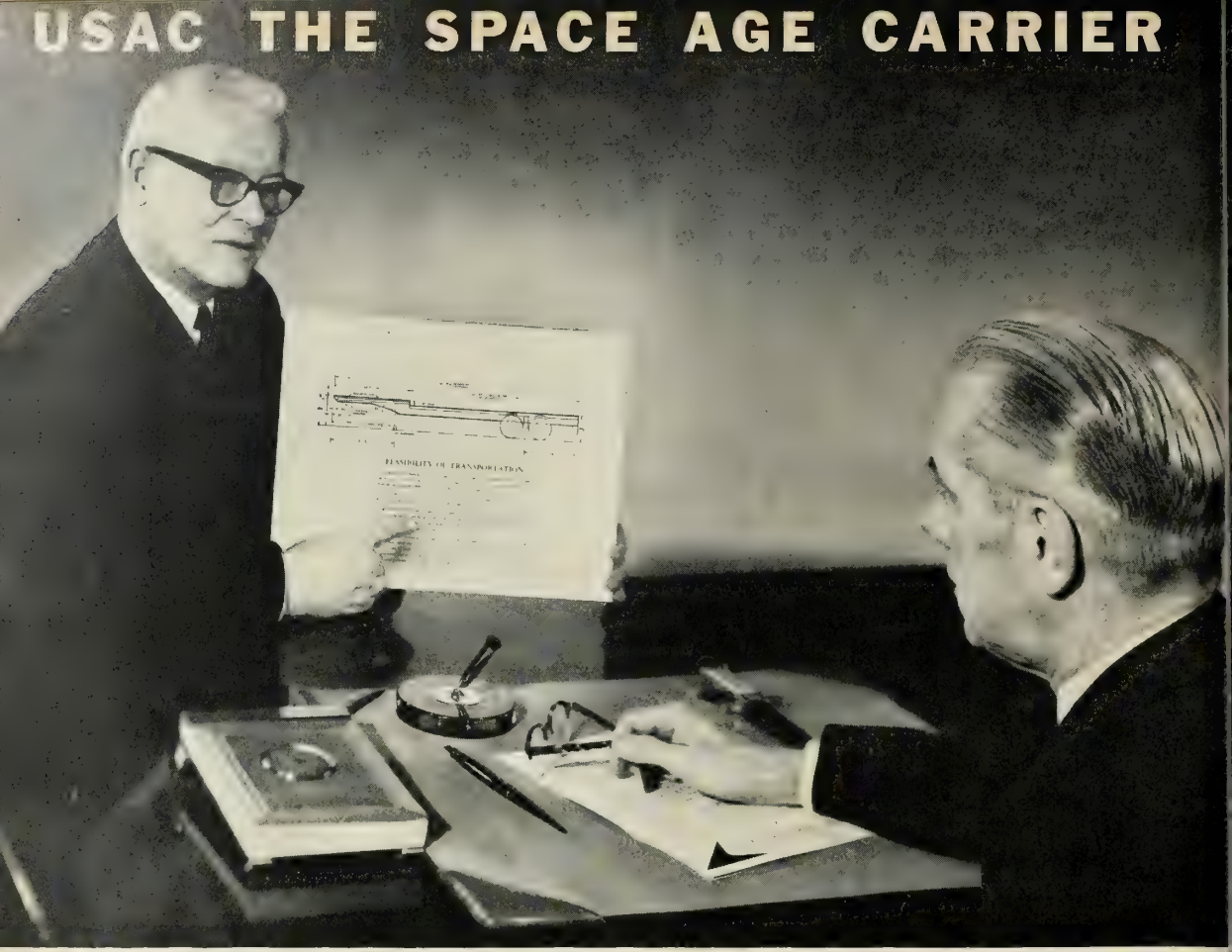
The other, Brig. Gen. Richard D. Curtin, serves on the secretary's staff as space systems supervisor.

• **Chief aides**—Like the other service secretaries, Zuckert has a policy board including the Under Secretary, the Assistant Secretary and the Chief and Vice Chief of staff. Also like the other secretaries, he will cut through red tape and organizational lines and deal directly with someone within the organization if he feels it is necessary.

His chief assistant is the Under Secretary of the Air Force, who may act with the full authority of the secretary



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on all affairs of the department. In addition, he supervises the analysis and review of Air Force requirements.

Assistant Secretary for Research and Development Brockway McMillan is Zuckert's principal staff assistant in scientific and technical matters; basic and applied research; exploratory development and advanced technology; integration of technology with and determination of qualitative Air Force requirements; test and evaluation of weapons, and technical management of systems and engineering.

Assistant Secretary for Material Joseph S. Imire is responsible for material and logistics planning; maintenance and modification program; supply management; procurement activities including required determinations and findings; contracting and administration of contracts; communication and other service activities; industrial resources and the industrial defense program.

Assistant Secretary for Financial Management Neil E. Harlan directs budgeting; budget review for Air Force requirements; accounting system; finance—including disbursement and collection of funds; progress and statistical reporting, management analysis, and program status reports; auditing, and contract financing. He is also responsible for direction of the comptroller of the Air Force. While the comptroller is directly responsible to Harlan, he has a concurrent responsibility to the Chief of Staff.

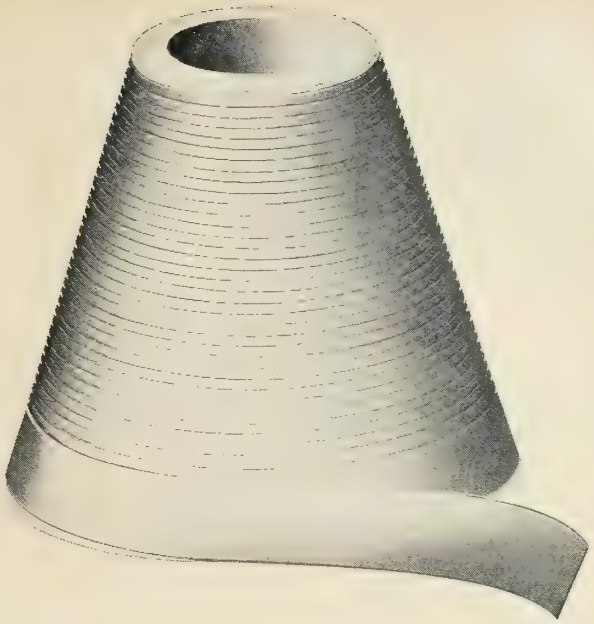
Special Assistant for Installations Alan I. McCone directs installation planning and programming, acquisition and disposal of real estate, construction of bases and facilities, family housing, and labor relations.

ARMY

ARMY SECRETARY Vance is a firm believer in the McNamara way of doing things. As a result, he has ordered a revision of the responsibilities of his chief assistants. His objective is more centralization of authority within the department.

Specifically, he wants to develop more coordination between the Assistant Secretary for Research and Development and the Army Chief of Research and Development. Vance wants the two to work closely on a proposal right from its inception. If they are in disagreement, he wants the disagreement made known to himself as well as the Army Chief of Staff.

While other details of the revision are still closely guarded secrets, it is known that in the future, rather than delegate certain responsibilities, Vance



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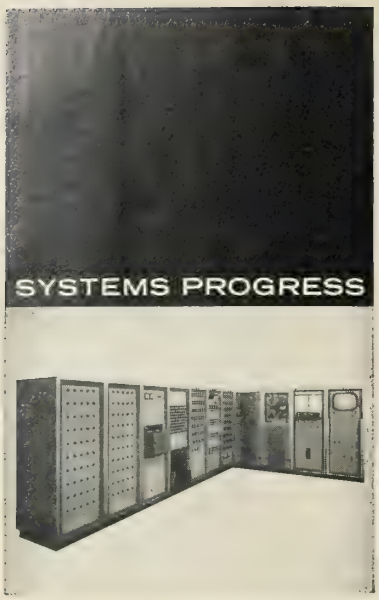
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intends to deal directly with the Army Chief of Staff.

Currently, R&D matters are handled in the following fashion:

The Army Chief of R&D presents the proposal to the Assistant Secretary for R&D. After it is staffed for its procurement and financial aspects, the two make a presentation to Vance. Usually, the Army Chief of Staff is present. If Vance approves, the proposal usually becomes an item for entry in a five-year program plan.

Vance's chief deputy is Under Secretary of the Army Stephen Ailes.

His other major assistants include:

Assistant Secretary of the Army (Financial Management) E. T. Pratt, Jr., who is responsible for budgeting and funding, development and evaluation of accounting system, auditing, financial assistance to private contractors, and civil functions of the Department of the Army.

Assistant Secretary (Installations and Logistics) Paul R. Ignatius, who directs procurement and procurement policy. Procurement policy which affects research and development must be coordinated with the Assistant Secretary for R&D. In addition, Ignatius is responsible for materials and materials requirements, construction, and engineering at industrial facilities.

Assistant Secretary (Research & Development) is Finn J. Larsen. He is responsible for research, development, test and evaluation including R&D procurement. He is also responsible for coordination with other Federal agencies and monitoring of the RDT&E budget and funding.

NAVY

NAVY SECRETARY Korth is currently considering a reorganization plan for his department. It follows a comprehensive review of the Navy organization which he ordered in January, 1962. The Navy department spent a whole year in its preparation; its result in terms of a streamlined organization is expected at any moment.

While Navy officials are reluctant to discuss their final report, it has been learned that one proposal under consideration is a switch in the offices to which the various Navy bureaus will report.

Currently the bureaus—which have the responsibility of meeting the requirements established by the Navy military officials—report directly to the civilian assistant secretaries of the Navy.

The change under consideration would have the bureaus report directly to the Chief of Naval Operations.

This would be especially important in the R&D project area. Under the current organization, when the Chief of Naval Operations establishes a requirement for a new project, it must first go to the civilian secretariat, from which it filters down to the Bureaus which perform the development work. Direct report to the CNO is almost certain to improve and speed up the flow of R&D work. It will also give the CNO more control over R&D projects.

Korth's chief assistant is Under Secretary of the Navy Paul B. Fay, Jr. In addition to that duty, he is responsible for policy, management and control of functions relating to personnel (military, civilian, and reserve forces), including coordination of the Navy leadership program.

Assistant Secretary for Navy Research and Development James H. Wakelin is the chief of Navy development programs. Along with Secretary Korth and the chief financial assistant, he approves all system program packages before they are forwarded to OSD.

Assistant Secretary of Navy for Installations and Logistics Kenneth Belieu is responsible for setting policy, managing and controlling the production of Navy bureaus, procurement which is directed by the Office of Navy Material, supply and distribution of material. He is also in charge of Navy real estate and facilities.

Assistant Secretary for Financial Management Victor M. Longstreet is charged with preparation of the Navy budget, accounting system, statistical reporting and auditing.

Another major change in the Navy organization which is under consideration would bring it more in line with the organization of the departments of the Army and Air Force.

This would call for having the Joint Chiefs of Staff report directly to the assistant secretaries, rather than reporting directly to Secretary Korth.

• **Distinctive setup**—The Secretary exercises his responsibilities in directing of the whole of his department through a bilinear system of organization. This distinguishes the organization of the Department from those of the Departments of the Army and the Air Force.

This bilinear system recognizes a "consumer-producer" relationship within the Department of the Navy and draws a distinction between *military direction* and *business direction* of the Department. *Military direction* is concerned with training and developing the capabilities and readiness of military forces, with planning and determining their support requirements, and with the military administration of the Department; *business direction* is concerned with providing the equipment, material,

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trained personnel, and services necessary to meet the supporting requirements of the military forces.

—*"Consumer - Producer" Relationship*—The military chiefs of the Department of the Navy, i.e., the Chief of Naval Operations and the Commandant of the Marine Corps, are viewed as representing the "consumer" of supporting requirements; hence, they are responsible for planning requirements for support in terms of what is needed, when it is needed, and where it is needed.

Thus, the Office of the Chief of Naval Operations, the Headquarters, U.S. Marine Corps, and the Operating Forces of the Navy and Marine Corps constitute the "consumer organization". In contrast, the bureaus and their shore activities, under the direction of the Under Secretary and the Assistant Secretaries of the Navy, are viewed as the "producers" of support and constitute the "producer organization."

In some instances the Office of the Chief of Naval Operations and the Headquarters, U.S. Marine Corps, have support responsibilities, and in those matters they come under the direction of the Under and Assistant Secretaries of the Navy, and are a part of the producer organization. This "consumer-producer" relationship is the essential basis for the division of responsibilities and tasks in the field of logistics and support.

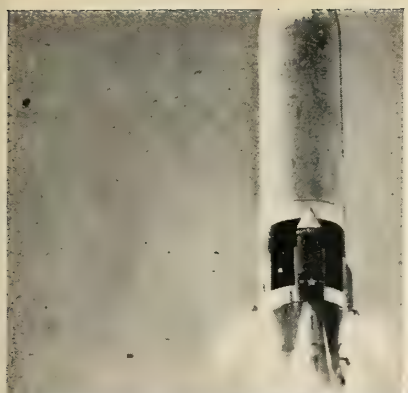
—*Military Direction*—It is through this line of authority that the Chief of Naval Operations and the Commandant of the Marine Corps exercise their responsibility for the task of naval command, and for their assigned portion of the task of logistics administration and control.

The Secretary of the Navy exercises his authority in military direction through, and by delegation of authority to, the Chief of Naval Operations and the Commandant of the Marine Corps.

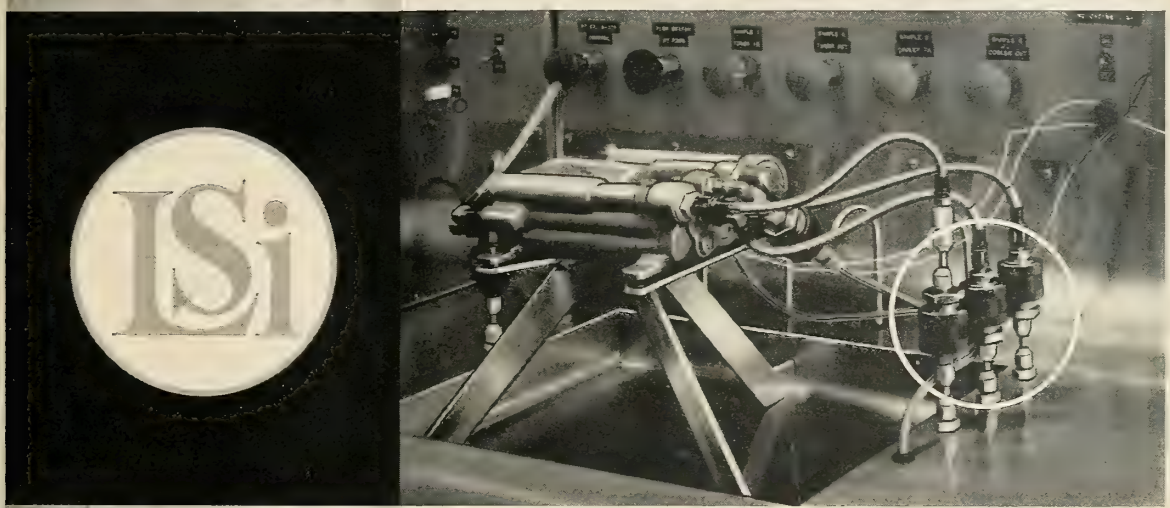
—*Business Direction.* Through this line of authority the civilian executive assistants and chiefs of bureaus and offices carry out the task of business administration of the Department and their assigned portion of the task of logistics administration and control.

The Secretary of the Navy exercises his authority in the field of business direction through, and by delegation of authority to, the Under and Assistant Secretaries of the Navy. The Under and Assistant Secretaries, as a group, are assigned responsibility for supervision and management of the work and operating efficiency of the Department of the Navy in meeting requirements of the Operating Forces of the Navy and of the Marine Corps. ■

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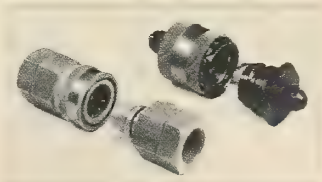


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DSA Big Factor in Cost Efficiency

Gen. McNamara's group faces critical test in next two years; officials stress that they're not in the 'weapons business'

DOD's "SECOND" Mr. McNamara is a 57-year-old Army Lt. General—full name: Andrew Thomas McNamara—who was picked by his boss, Secretary McNamara, to head the newly created Defense Supply Agency.

Needless to say, both Messrs. McNamara have had a strong impact on the Dept. of Defense.

In its freshman year, after moving into operational status Jan. 1, 1962, DSA scored such major reductions in supply procurement costs, operating expenses and inventory that even its most severe critics in both the military and Congress have softened their objections to this potential Goliath of the defense establishment.

However, the crucial test for DSA will come this year and next, as its operations expand into more commodity areas, including the highly critical electronics area. Many observers feel that the agency's future may be tied to its ability to manage these technically complex commodities, which alone are expected to account for a half-billion items by 1964.

DSA's current scope is vast, and its prospective domain is even greater. For this reason, Gen. McNamara's chain of command runs directly to Secretary McNamara, with whom he attempts to meet regularly on a weekly basis. The General is on the same level as the service secretaries and the Joint Chiefs.

In the broad DOD logistics network, DSA exists as the fourth major procurement agency, adding its responsibility for common-use, service-wide items to the specific service-related procurements handled by the individual branches of the armed forces.

The services determine the requirements. DSA computes these in order to make one buy, and then sees that the service customers get what they need.

• **Some doubts**—It is really the potential scope of DSA which caused some minority opposition to its creation in both Congress and the military. Many criticisms have been silenced by the excellent first-year accomplishments, including what the SecDef called an outstanding job of fast action during the Cuban affair last October. But certain Congressmen are expected to continue close scrutiny of DSA activities for quite a while.

One major fear associated with creation of DSA was that so large a group, with so much of the procurement dollar, acting directly under the SecDef (rather than the Joint Chiefs) would be a big step toward creation of a single service. Naturally, this broad prospect was not extremely popular within the services. Some officials within service logistics also felt that even if DSA never progressed to that point, it constituted a reduction of their individual empires.

Another initial reaction, tied to this same basic point, was that DSA would interfere with the military's combat readiness and its ability to quickly supply its operating forces with the needs for combat.

DSA officers, however, strongly emphasize the agency "is not in the weapons business." DSA does not figure at all in initial buys in weapons systems. It may get in on certain replenishment buys, but procurement of combat-related items and items subject to design changes is retained by the services.

DSA will manage only those supply items which can be centrally managed and those which are coded by coordinated armed services and DSA determination as applicable to DSA procurement.

• **Minor missile/space role**—DSA's current involvement in missile programs is very small, limited mostly to ground-support items (at the Columbus, Ohio, Construction Supply Center) for some of the early-generation programs. The Defense Electronics Supply Center, recently put into operation at Dayton, will also have an involvement in parts, but these, it is stressed, will be common resistors or capacitors, for example, which may be applicable to several different systems and prove feasible to procure in bulk.

By nature of its charter to supply common-use items, DSA has virtually no role in military space procurement. Though its missile role may expand slightly, its space buying role is not likely to grow for several years, if at all.

This fact is important for the missile/space industry, where the message of DSA has not entirely stuck. DSA reports it still gets calls from firms that think the agency now handles all DOD procurement of all items.

One of the objections to DSA which is sometimes raised revolves around this issue: basically, if DSA continues to function well, there is really nothing to prevent the SecDef from expanding its charter, first into some of the marginally combat-related items, and then farther down the line—virtually removing the bulk of procurement duties from the individual services.

• **Business scope**—DSA procurement currently represents about 15%, or $3 billion, of DOD's FY '63 procurement. In its first year, a DSA spokesman reports, the agency reduced procurement costs to about $30 million below what the service estimates would have been for the same tasks. In addition, savings in personnel costs during FY '63 and projected into FY '64 (affecting about 4000 jobs), resulting from consolidation of formerly separate overhead organizations, have produced a reduction in the FY '64 request of $33 million.

A reduction in inventories valued at $232 million in FY '63 will also result from the consolidation. An additional $112 million inventory drawdown is expected in FY '64. By the close of FY '63, DSA's management inventory will exceed 1.1 million items worth about $3 billion. By close of FY '64 this will probably grow to at least 1.3 million items, reflecting full assumption of supply management responsibilities for electronics items. The DESC on March 1 took over some 400,000 AF items. During FY '64, this number will in-

crease to roughly 700,000, as Army and Navy parts are added.

DSA provides service on about four million items in the defense section of the Federal supply system, including those it manages.

Additional economies have grown out of DSA responsibility for screening new products, long-supply stocks, and idle production inventories; and from reducing the number of primary distribution depots from 32 to 12. By FY '65, savings in DSA operating expenses alone will net an estimated $42 million.

• **Missions**—The scope of DSA is contained in its brief summation of its mission: to provide management of standardization, cataloguing, utilization, and disposal programs for the entire DOD; integrated supply management of assigned commodities; system planning and design for those commodities; traffic management for all of the DOD; coordinated procurement; system analysis and study to extend the scope of integrated management; and material inspection. To do all this requires about 25,000 persons.

As an example of its capabilities in the first category alone, DSA, responsible for the Defense Standardization Program, last year chopped 25,000 different items out of supply inventories. This has come mostly from industrial supplies and does not include any electronic items which are expected to produce sharp reductions.

The headquarters group is at Cameron Station, Va., a short distance from the Pentagon. From his office there, Gen. McNamara remains in close touch with both the SecDef, and Assistant Secretary (I&L) Tom Morris for coordinated policy guidance.

Though DSA is centrally managed from Cameron Station, it is essentially a decentralized field operation which leaves undisturbed all of the procurement routes and contacts it claimed when it took over operation of what had been a number of service-run single-manager commodity centers.

The current field organization consists of nine Defense Supply Centers responsible for subsistence, clothing and textiles, medical, general, petroleum, industrial, automotive, construction, and electronic items of supply. There are two service organizations—one responsible for material utilization, cataloging and surplus disposal, and the other for traffic management. The agency also manages several depots.

• **New duties coming**—During FY '64, new commodity or center managements may fall into DSA hands as a result of studies either recently completed or still under way.

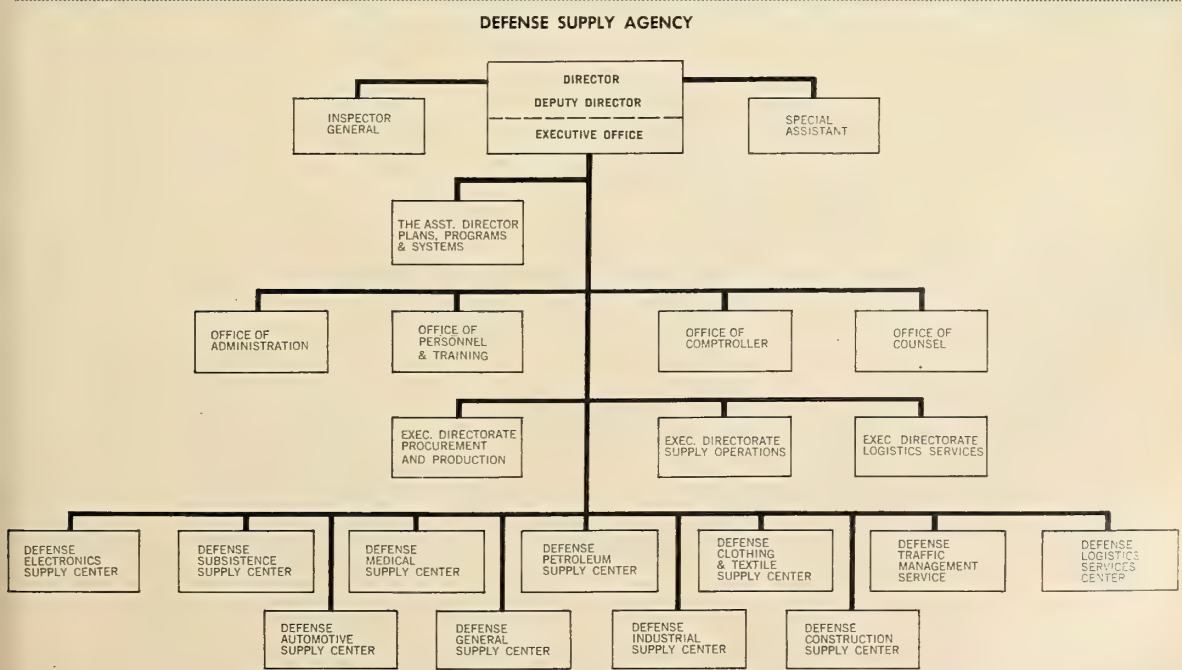
These include: common chemicals, probably implemented into DSA about July 1 and covering an estimated 6000 items annually, plus an additional $75-million procurement; a new industrial production equipment center, set up possibly by June, '64, which would involve inventory management work listing as many as 400,000 pieces of equipment, and possibly some long-range post-1964 procurement; and an aircraft spare parts project, still under study, which could be very far ranging.

This parts project may involve up to 150,000 items worth in excess of $6 billion. "If DSA winds up with a $20-billion inventory," says one DSA spokesman, "this is where it will come from. The potential is tremendous." So is the sensitivity, for this, which could easily be extended in more combat-type missile spares, touches on one of the controversial areas of DSA involvement.

DSA is operating its procurement activities along the same basic guidelines as are the three services: namely, increase competition, get the best price, and don't forget small business. DSA reports that 93% of its dollars are spent competitively, and roughly 46% is with small business (far beyond the DOD average). It is always trying to increase its bidder's list, especially in the small business representation.

Placement and administration of DSA contracts is handled directly by the field commodity managers at their field locations. Contracts for more than $1 million mean a trip to Cameron Station for the field personnel for review. If the new commodity managements and centers are established, these will represent the only really new contacts for industry.

For a complete list of DSA activities, including names and addresses, interested firms should contact the procurement and production affairs officer at Cameron Station, Alexandria, Va. ■





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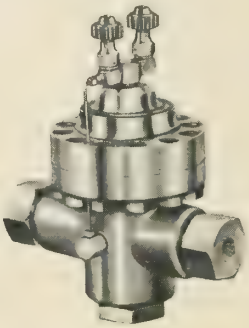
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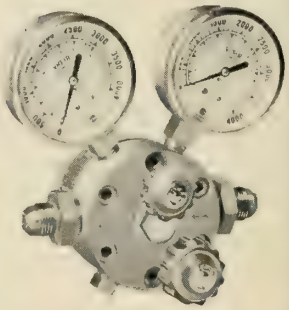
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Agency consists of National Military Command System, Defense Communications System and ComSat Project Office

DEFENSE COMMUNICATIONS AGENCY (DCA) is an instrument developed by the Office of the Secretary of Defense to unify, coordinate, utilize, and improve global military communications and command systems.

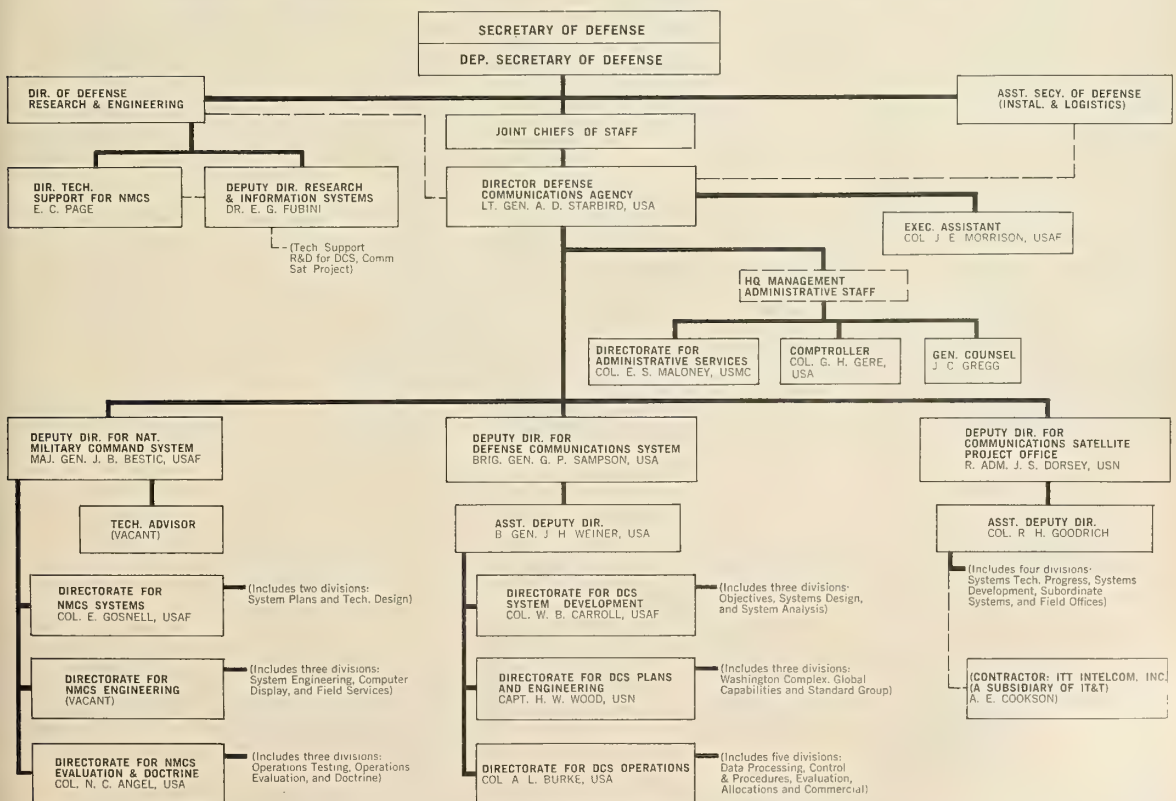
Forged first in May, 1960, by then Secretary of Defense Thomas S. Gates, Jr., as a tool for establishing and directing a centralized Defense Communications System (DCS), DCA more recently has been reworked under Defense Secretary Robert S. McNamara's hand to perform multiple management services in associated technologies.

Last summer, McNamara approved separate memoranda assigning distinct responsibilities for establishment of a National Military Command System (NMCS), and for a reconstituted military communications satellite program. As a result, DCA established organizational elements for three equivalent deputy directors—one was set up for NMCS, one for a Communications Satellite Project Office (CSPO), and the former Chief of Staff for DCA was officially redesignated to direct DCS activities.

● **Basic responsibilities**—DCA is under the direction, authority and control of the Secretary of Defense. The normal chain of command is from the Secretary to the Joint Chiefs of Staff to the Director, DCA. However, under the terms of the Reorganization Act of 1958,

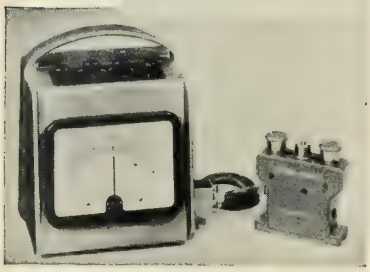
DEFENSE COMMUNICATIONS AGENCY:

Organizational Structure and Chain of Command, Technical and Operational, (As of March 4, 1963)



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Division of Engineering and Scientific Instrumentation

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the Director of Defense Research & Engineering (DDR&E) is specifically charged with the responsibility of supervising all Department of Defense research, development, test and engineering activities (see p. 80).

As the principal advisor to the Secretary of Defense for research and engineering activities, DDR&E wields considerable authority and influence over DCA, but chiefly with respect to NMCS and CSPO. DCS is evolving as an operating system. It requires less R&D and thus is primarily under supervision of DDCA and his Deputy Director, the Joint Chiefs of Staff, and the Assistant Secretary of Defense-Installations & Logistics

NMCS and the CSPO are essentially R&D programs. To facilitate technical support for these new and important elements of DCA, DDR&E provides two offices of responsibility: Deputy Director for Research & Information Systems and the Director of NMCS Technical Support.

• **Functional supervision**—In general, DDR&E is responsible for functional supervision of DCA activities. He is charged with planning, directing, and supervising the execution of technical support for the agency. Also, DDR&E provides policy guidance and technical direction, allocates major implementation responsibilities to the appropriate DOD components, reviews technical plans, reviews accomplishments, consolidates budgets and controls funding.

A major task of the Joint Chiefs of Staff is to provide the Secretary of Defense with recommendations for functional system design, changes in functional requirements, and correction of operationally revealed weaknesses or inadequacies in existing or planned DCA systems.

• **Implementation supervision**—DCA's Director, Lt. Gen. A. D. Starbird, is responsible for systems engineering and for technical supervision of the implementation of technical support throughout all of the agency's subordinate DOD components as directed by OSD and DDR&E.

The largest organizational element of DCA today is the office of the director of the Defense Communications System, Brig. Gen. G. P. Sampson. DCA's mission, now that a large part of the existing long-haul, point-to-point telecommunications facilities of the many DOD components have been tied together into a single global network, is to ensure that the system is steadily improved and continues to meet the long-term requirements of DOD and any other governmental agencies when so directed.

DCA has had the task of bringing together—and in many instances eliminating—the terminals and circuits of hundreds of fixed installations of the three military departments and assuring their operational compatibility. It is important to note that not only was DCA assigned responsibility for this task but the initiating directive specifically stated that no other facilities were authorized to fulfill the same purpose.

Nine months after its creation, DCA announced activation of the Defense National Communications Control Center (DNCCC), located near Washington, D. C. In rapid succession thereafter, four area (DACCC) centers were established—in Europe, Hawaii, Alaska, and the continental U. S. (at Ft. Carson, Colo.). Six regional (DRCCC) centers also were placed in operation—three in Europe (U. K., Turkey, Spain), another in Labrador, and two in the Pacific (Japan, Philippines).

Operation of the entire system is monitored by these centers. Computers, data storage and processing equipment, and displays are provided. Circuit usage, outage, and a myriad of other operational data are collected hourly. From these data relating to the use of circuits, trunks, terminals, switching centrals—all the elements of the system—performance can be determined and operational weaknesses can be revealed. Also, the centers can direct the restoration of high-priority circuits, re-route traffic to minimize backlogs, and solve other circuit emergencies affecting the system.

DCA monitors, supervises, and directs, but it does not operate the communications facilities comprising the DCS. Operation, system maintenance, and contracting for hardware development, testing and installation are handled by the three military departments as directed.

Personnel under the office of the Deputy Director for DCS number 256. The empire that they oversee, however, is enormous. It encompasses a global complex involving a $2.5-billion capital investment and requiring from $600-700 million a year funding for operation and maintenance by the military departments. Nearly 32,700 personnel operate circuits providing 10.9 million miles of telecommunications channels. Components of the system are located in 73 countries, and the intricate web includes 85 major networks or subsystem complexes.

DCA also is responsible for three other field activities (in addition to the 11 communications control centers): the White House Communications Agency, the Defense Commercial Communications Office, and the NMCS Support Center.

• **NMCC by '67**—The presently planned date for DCA's National Military Command System organization to



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become operational is April 1, says Maj. Gen. J. B. Bestic, deputy director for NMCS.

Over the next few years, Bestic's team of experts will provide the doctrine, procedures and design for a unified global system of facilities, equipment and communications for use by the national command authorities in providing strategic direction of U. S. Armed Forces.

An interim system, the general pointed out, will be in use late this year, or early in 1964. While offering only limited capability, the "quick-fix" system will provide a means of learning more about the problems of providing timely and necessary information to the top U. S. command elements.

This early system will include an upgraded Joint Chiefs of Staff War Room. It will have limited computer and display capability.

The NMCS staff, now only at 50% strength, will number 130, mostly military officers and civilian professionals of highly specialized training.

Preliminary designs for the first-generation NMCS are now being developed for DDR&E review.

As presently envisioned, NMCS will employ a primary National Military Command Center (NMCC) and an alternate (ANMCC), plus an undetermined number of subordinate command centers, widely dispersed.

Completion of the NMCC and at least a working NMCS are expected by 1967, he said. Establishment of the NMCC will represent the first true interface with all military command elements down to the unified and specified commands.

• **Joint venture**—Smallest of DCA's headquarters activities is the Communications Satellite Project Office. Directed by Rear Adm. J. S. Dorsey, the office is responsible for assisting in determining requirements for a ComSat program involving possibly 24 medium-altitude random-orbiting vehicles.

CSPO's principal task is the integration of the entire R&D program and the determination of the interface between spaceborne and supporting and connecting ground facilities. Its ultimate goal is the integration of the operational ComSat system with the then existing DCS.

Functional control over CSPO is maintained by DDR&E. In addition, CSPO personnel work directly with DDDCS, NMCS, Air Force Space Systems Div., and the Army Satellite Communications Agency.

The Air Force, through SSD, is program manager for the satellite and launch portion of the development effort; ASCA at Ft. Monmouth is program manager for the ground environment. ■

Decision-Making: Logistics Support... What, Where, When?

Centuries ago the critical factor in logistics support was providing basic supplies—food, armaments, raw materials for simple industries. A few decades ago, carrying capacity—sea and land transportation—ruled as the decisive element. Within the last decade, a new critical element in logistics support has emerged. It has been created by the complex, interfacing governmental, industrial and military structure of today. This new factor is up-to-the-minute information—gathered from afar, varied in content, immense in volume.

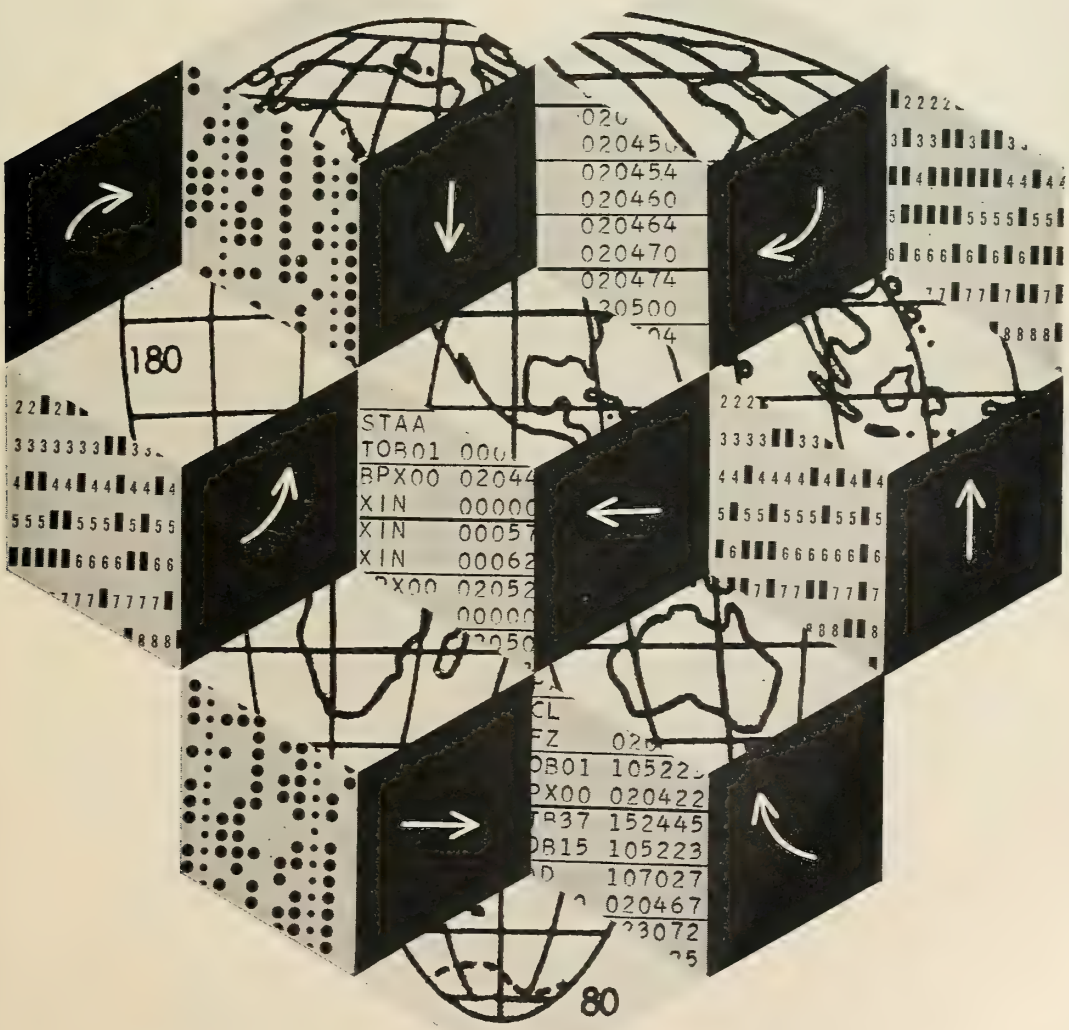
To help provide and control this flow of information, SDC scientists, and engineers have helped create a new technology: information systems which aid managers in determining the "what, where and when" of logistics support for world-wide and continental activities and forces.

In developing these systems which provide information processing assistance, SDC scientists and engineers have evolved an interdisciplinary approach. Teams of operations research scientists, engineers, computer programmers and human factors scientists work together in these major system development steps: analyzing the system, synthesizing the system, instructing computers within the system, training the system, evaluating the system—and helping adapt the system to the changing needs of its users.

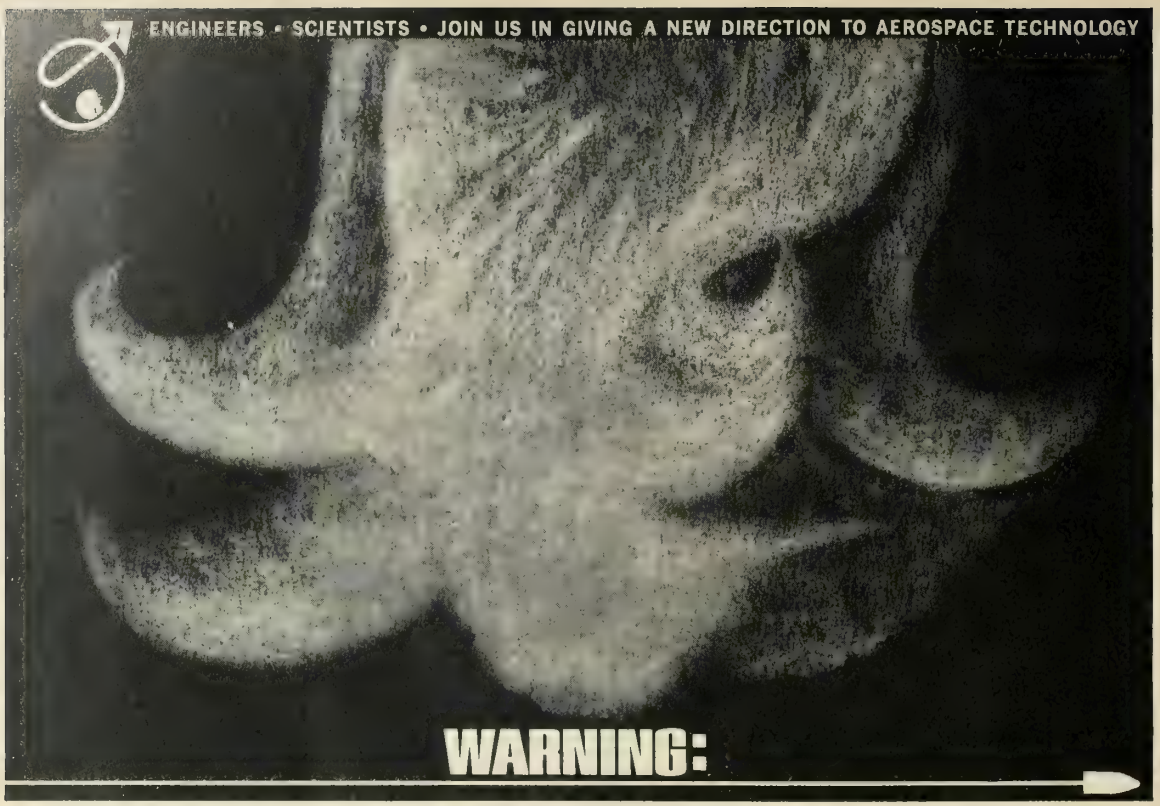
Scientists and engineers interested in joining this growing field are invited to write Dr. H. H. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Massachusetts; Paramus, New Jersey; Dayton, Ohio. "An equal opportunity employer"

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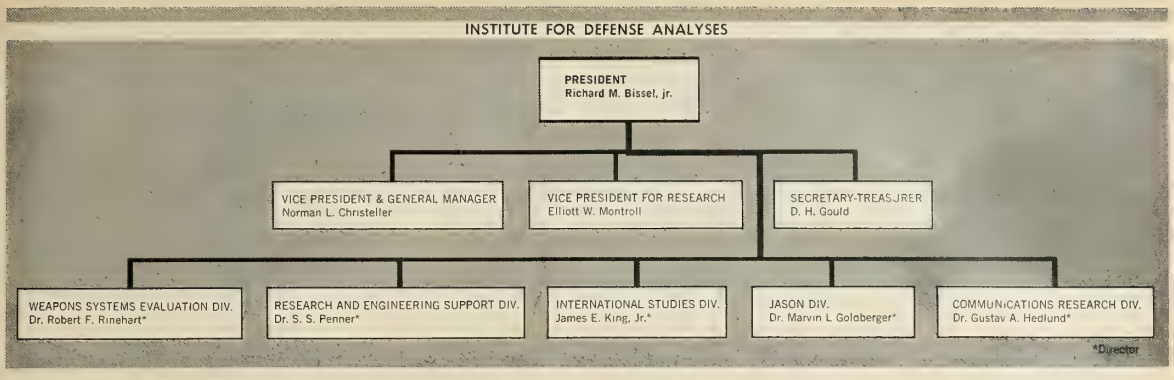
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INSTITUTE FOR DEFENSE ANALYSES (IDA), sponsored by eleven of the nation's leading universities and guided by a board of highly influential citizens, operates under several non-profit contracts—mostly with the Department of Defense—to provide many of the technical studies needed for top-level decisions of great consequence.

The Weapons Systems Evaluation Division (WSED), accounting for 40% of IDA's income of about $10 million a year, provides the scientific support team to DDR&E's (Director, Defense Research & Engineering) Weapons Systems Evaluation Group (WSEG). (See p. 80.)

WSEG plus WSED—collectively known as WSEG—is in the unique position of performing military operations-research work on a multi-service level—a necessary condition for unbiased reporting to the DOD level.

WSEG, moreover, comprises working teams of military personnel and civilian scientists for continuing two-pronged attacks on defense problems—a method also unique and necessary for effective defense analyses.

● **IDA's five divisions**—The civilian portion of WSEG was administratively spun off as WSED in 1955, and a year later became the sole division of the newly formed IDA. Subsequently, part of the work performed by the Advanced Research Projects Agency (ARPA) was also transferred to IDA. To perform the additional function, the Institute set up its Research and Engineering Support Division (RESD), under contract to DDR&E through ARPA.

RESD, in contrast to WSED, is concerned with making technical judgments about weapons and defense systems rather than delving into the economic, tactical and strategic implications.

IDA today has three divisions in addition to those named: Communications Research (CRD), Jason, and International Studies (ISD).

CRD employs about 20 professional people, most of them scientists on loan from universities. They work under contract to the Office of Naval Research (ONR). The CRD personnel are interested mainly in physical phenomena the Navy might be able to use to carry out its mission more effectively.

Jason, operating under the RESD contract, is a loosely knit organization of about 40 brilliant and relatively young physical scientists and mathematicians employed at universities and tagged as "being on their way up." They meet for six to eight weeks during the summer for working sessions and briefings by DOD technical personnel.

The idea is to expose these men to defense problems and get the benefit of their inputs without taking them away from their jobs at the universities. The scientists, presumably thinking about defense problems during the year, keep in touch with one another by mail and interim meetings.

Unlike other IDA divisions, ISD works mostly on individual small contracts. Predominantly in the social sciences field, the major part of ISD's work is for DOD's International Security Affairs office; lesser contracts are with the Arms Control and Disarmament Agency, and the State Dept.

● **In practice**—The duties of three of IDA's divisions can be drawn in their main outline, but when it comes to practice the outlines are sometimes blurred—depending on the interests of the sponsoring agencies and also of the divisions themselves.

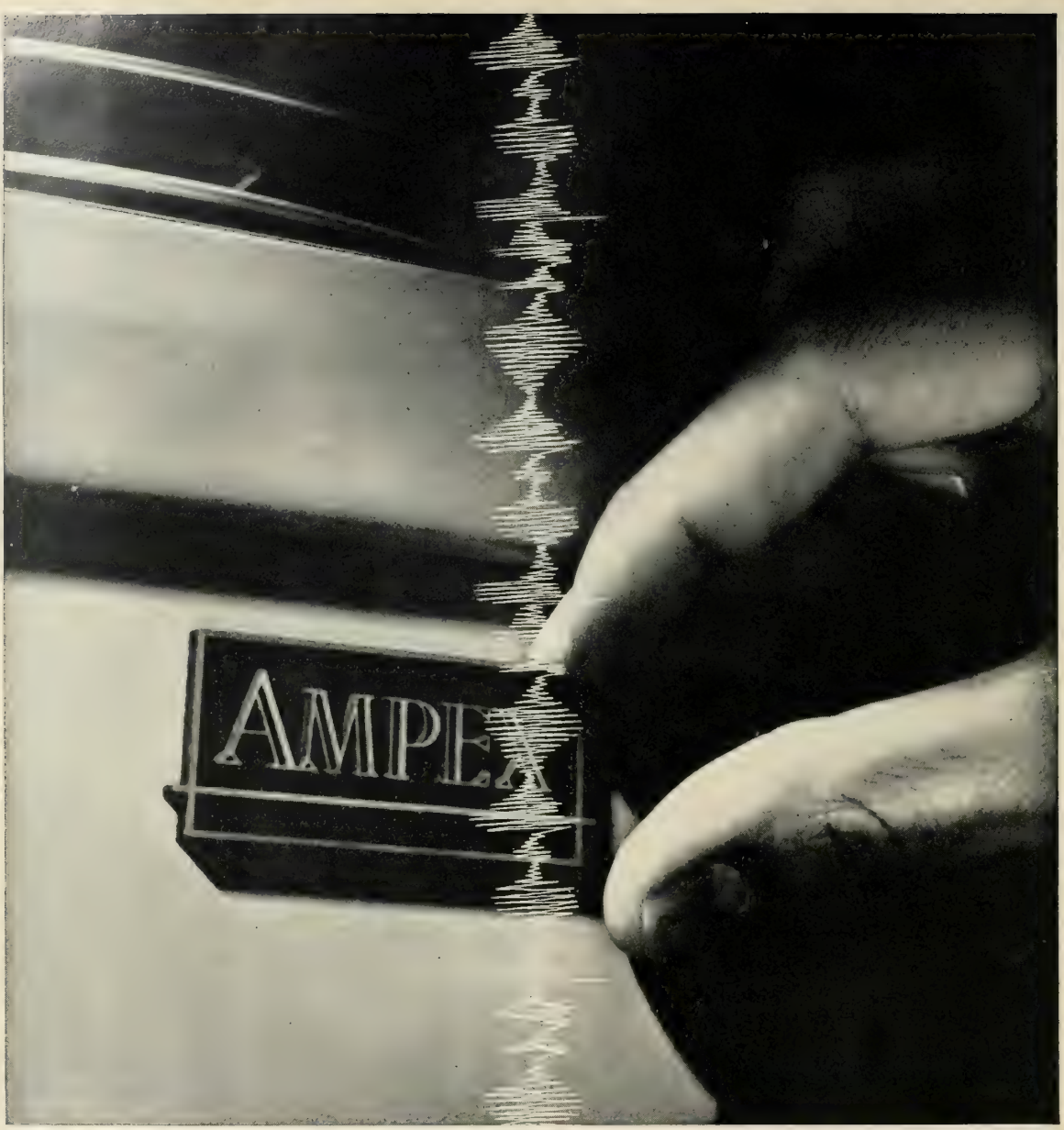
The conceptual differences, however, may be illustrated as follows:

—*Jason* works at the most theoretical level. It asks whether we understand a physical phenomenon well enough to use it in some kind of defense effort. Do we know enough about the laser principle, for instance, to make some practical use of it—or is more theoretical understanding needed? If more theory is needed, what is the best way to proceed?

—*RESD* assumes that the physical phenomenon is well understood and the technology is at hand. Now, asks RESD, how can the phenomenon be applied in practical terms to a weapon system or the defense effort? RESD, in effect, has the laser technology and tries to decide what to do with it on purely technical grounds.

—*WSED* looks at the broad economic-technical-military picture and tries to work out the interactions. Given the laser art, for example, and the weapon systems it can build, will the dividends from the required investment of time and money be worthwhile? What are the military implications? Perhaps areas such as chemical and biological warfare offer more of a payoff for the same investment.

Clearly, the professional force of the Institute is made up of people of many backgrounds and disciplines. Their work, referred to by the highest echelons in DOD, is therefore an unpublicized but nonetheless highly important factor in defense decision-making. ■



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LMI Has Growing Effect on Planning

Non-profit group has already produced a dozen studies aimed at ensuring proper quality and quantity—at lowest cost

LOGISTICS MANAGEMENT INSTITUTE, though only a year and a half old, has turned out twelve studies which are expected to greatly influence DOD logistic planning.

The non-profit corporation was set up in the fall of 1961 by Secretary of Defense McNamara to bring "the most experienced and creative business management" to logistics problems.

Principal orientation of the Institute is toward defense procurement and materiel management. Its two objectives are 1) to ensure that what is bought and stocked is of adequate quality and quantity to support the requirements of peacetime and mobilization, and 2) to support it at the lowest cost.

The organization works on a contract basis with DOD, and performs these functions:

—*Requirements planning*—Develops procedures for rapid determination of procurement objectives to best support peacetime and mobilization inventories, and to reduce variety and cost of technical documentation.

—*Specifications, standards and designs*—LMI develops programs to eliminate unnecessary specifications and excessive quality and performance standards, to analyze cost savings techniques (such as value engineering), to improve design data retrieval and standardization, and to improve methods for control of engineering and design changes.

—*Optimum competition*—Develops techniques for conducting price competition, methods for judging the economics of competitive procurement, and means for more effective use of contract incentives and profit motives.

—*Procurement policies and practices*—Appraises the problems of evaluating the qualifications of contractors, reducing proposal costs, improving contract pricing and funding, simplifying purchasing and reporting procedures, and using technical data produced by contractors.

—*Weapons systems support*—Develops methods of reducing costs of weapons systems support, including initial procurement of spare parts, ground and test equipment and maintenance, training and documentation, without degrading the readiness posture.

—*Logistics operations*—Develops management control processes which measure and report logistics performance, effectiveness and efficiency.

The need for this type of management organization has become critical, DOD officials say, since 70% of the defense operation has to do with logistics. This includes $73 billion in capital equipment, $41 billion in supply inventory, $25 billion per year in new procurement, and $35 billion per year spent in logistics fields.

One of the most controversial of the surveys so far undertaken by LMI was a "study of profit or fee policy."

This study includes a formula which LMI drew up to aid DOD in arriving at equitable profit percentages for its contractors. This, like other LMI recommendations, will require approval by the Secretary of Defense before it becomes practice. One top DOD official told MISSILES AND ROCKETS: "I'm generally sympathetic with it, but some practical aspects need working out." It is believed that most of LMI's work will eventually become fact in one form or another.

● **Staff**—LMI has a staff of about 30 professionals, roughly a third of whom have doctoral degrees, a third masters', and a third bachelors'. Average experience in the logistics field is 17 years, with 50% coming from industry, 30% from consulting organizations and 20% from institutions.

The organization is headed by President Barry J. Shillito, former president of Houston-Fearless Corp. and once a director of Hughes Aircraft Co. Members of the Logistics Advisory Committee are Gen. Carter B. Magruder (USA-Ret.), Lt. Gen. William D. Eckert (USAF-Ret.) and Rear Adm. James W. Boundy (USN-Ret.).

Although the Institute is expected to stay at about the same size, it calls upon consulting organizations and universities for special studies when needed.

● **How LMI works**—Ideas for LMI studies usually are initiated by the services, say LMI officials. However, the organization also develops its own thinking about where its efforts should go.

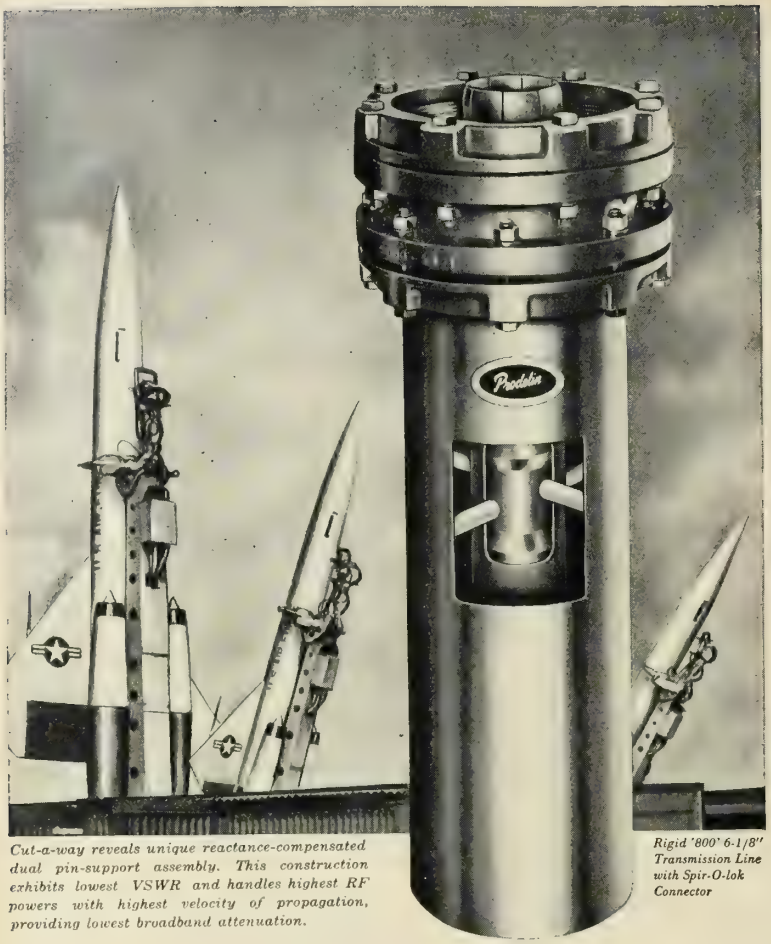
All studies so far have been on subjects of general interest to all three services, although it is conceivable the organization might take up an issue critical to one service only. It is also possible under law for the organization to do work for other government agencies or even non-profit organizations—but this is extremely unlikely.

Industry has been very cooperative, LMI officials say. Contact with industry may be made at any level, although top company executives are consulted. The Institute then observes the practices at working levels to make its report.

LMI is considered a supplement to the research capability of the Defense Supply Agency, the Assistant Secretary of Defense (Installations and Logistics) and the Materiel Assistant Secretaries of the Army, Navy and Air Force.

Its board of trustees, which meets quarterly to review the business and working affairs of the corporation, boasts such notable executives as:

Charles H. Kellstadt, former chairman of the board of Sears Roebuck and Co. (chairman); Stanley C. Allyn, former chairman of the board of National Cash Register; Maj. Gen. Frederick J. Dau (USAF) president, Paper Division of Champion Papers, Inc.; Peter F. Drucker, professor, Graduate School of Business, New York University; Dr. Neil H. Jacoby, dean, Graduate School of Business, UCLA; Robert J. Nordstrom, associate dean of Ohio State University College of Law; Dr. Carlton A. Pederson, associate dean, Graduate School of Business, Stanford University; Charles E. Wilson, former president, General Electric Co., former director of the Office of Defense Mobilization. ■



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A Sampling Of Pentagon Alphabet

AS A PRACTICAL matter, the Defense Dept. must use scores of abbreviations to designate its myriad agencies and offices. Here are some of those with significance for industry:

AFAAC	*AF Comptroller*
AFABF	*AF Budget Director*
AFADA	*AF Asst., Data Automation*
AFAMA	*AF Director, Status Analysis*
AFASC	*AF Director, Data Systems & Statistics*
AFAUD	*AF Auditor General*
AFCCS	*AF Chief of Staff*
AFCOA	*AF Operations Analysis Office*
AFRDC	*Deputy Chief of Staff, Research & Technology, AF*
AFRDP	*Director of Development Planning, AF*
AFRDR	*Director of Research, AF*
AFRDT	*Director of Advanced Technology, AF*
AFRRP	*Asst. for Research & Programming, AF*
AFSPM	*Director of Procurement Management, AF*
AFSSA	*Director of Systems Acquisition, AF*
AFCC	*Air Force Communications Center*
AFSC	*Air Force Systems Command*
ARPA	*Advanced Research Projects Agency*
ASTIA	*Armed Services Technical Information Agency*
COMP	*Comptroller, DOD*
DCA	*Defense Communications Agency*
DDR&E	*Director, Defense Research & Engineering, DOD*
DLSC	*Defense Logistics Service Center*
DNCCC	*Defense National Communications Control Center*
DSA	*Defense Supply Agency*
I&L	*Installations & Logistics, DOD*
INSORD	*Office, Naval Inspector of Ordnance*
JCS	*Joint Chiefs of Staff*
OAR	*Office of Aerospace Research*
OASA (FM)	*Office, Assistant Secretary of the Army (Financial Management)*
OASA (I&L)	*Office, Assistant Secretary of the Army (Installation & Logistics)*
OASN (R&D)	*Office, Asst. Secretary of the Navy for Research and Development*
OCRD	*Office, Chief of Research & Development*
OCSA	*Office, Chief of Staff, Army*
ONM	*Office of Naval Material*
ONR	*Office of Naval Research*
OSA	*Office, Secretary of the Army*
OSD	*Office, Secretary of Defense*
OSN	*Office, Secretary of the Navy*

(*continued on p. 121*)



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(Continued from page 118)

OAR-N	*Office of Analysis & Review, Navy*
OC-N	*Office of the Comptroller, Navy*
OIR-N	*Office of Industrial Relations, Navy*
OP Nav	*Office, Chief of Naval Operations*
OSD/COMP	*Comptroller, OSD*
OSD/DDR&E	*Director of Defense Research & Engineering, OSD*
OSD/I&L	*Asst. Secretary of Defense (Installations & Logistics), OSD*
OTIA	*Ordnance Technical Intelligence Agency, Army*
OUSA	*Office of the Under Secretary of the Army*
OUSN	*Office of the Under Secretary of the Navy*
PCP	*Program Change Proposal*
PDP	*Program Definition Phase*
PERG	*Production Equipment Redistribution Group*
PJBD	*Permanent Joint Board on Defense, Canada-U.S.*
QMRPA	*Quartermaster Radiation Planning Agency*
RDB	*Research and Development Board (defunct)*
RESG	*Research Engineering Standing Group*
RFP	*Request for Proposal*
SAFS	*Secretary of the Air Force*
SAFIE	*Special Asst. for Installations, SAF*
SAFMA	*Asst. Secretary of the Air Force (Materiel)*
SAFMS	*Office of Missile and Satellite Systems, SAF*
SAFRD	*Asst. Secretary of the Air Force (Research & Development)*
SAFUS	*Under Secretary of the Air Force*
SecDef	*Secretary of Defense*
SIG	*Signal Officer, Office of the Chief*
S&L	*Systems & Logistics*
SSD	*Space Systems Division, USAF*
USAAA	*Audit Agency, Army*
USACDC	*Combat Developments Command, Army*
USACSA	*Combat Surveillance Agency, Army*
USAICA	*Interagency Communications Agency, Army*
USASCC	*Strategic Communications Command, Army*
USASCSA	*Signal Communications Security Agency, Army*
USATAFO	*Transportation Aviation Field Office (Liaison Office), Army*
USCONARC	*U.S. Continental Army Command*
WEPS	*Bureau of Weapons, Navy*
WHCA	*White House Communications Agency*
WSED	*Weapons Systems Evaluation Division (IDA)*
WSEG	*Weapons Systems Evaluation Group*



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Dearborn has *launched* another significant product addition with CTM type capacitors which meet or exceed the stringent requirements of Mil-C-27287 (USAF).

Outstanding characteristics include:

- Tested to Mil-C-27287.
- Size and weight reductions over "other" offerings. For example, a .01 mfd unit at 50 VDC is only .172" diameter by 7/16" long.
- Excellent resistance to shock, vibration and humidity.
- Ideal where reliability must not be forfeited for miniaturization.

Dearborn CTM capacitors are vapor-seal wrapped of tubular configuration, ends potted with a unique resin. Capacitance values range from .001 through 1.0 mfd. Operating voltage range is 50 DC to 300 DC at +125°C. *Twice* rated voltage from −55°C to +85°C.

Dearborn CTM capacitors are ideal where severe space restrictions exist . . . yet optimum reliability is a prime requirement.

Write for Engineering Data 27287!

Dearborn ELECTRONIC LABORATORIES INC.

P. O. Box 3431 • Orlando, Florida • Phone: DDD-305 838-3011

© 1963 DEARBORN ELECTRONIC LABORATORIES, INC.

I.E.E.E. BOOTH 2937

Circle No. 31 on Subscriber Service Card

NEW B.F.GOODRICH FILAMENT WINDING FACILITIES PRODUCE GIANT STRUCTURES

Extending its capability for producing filament-wound rocket motor chambers and other products, B.F.Goodrich has opened new facilities for even larger structures. Highlight of the new plant is the special winding machine (see photo) which can wind chambers up to maximum sizes for land transport.

This machine is designed to produce polar, helical, geodesic and circumferential winds—or any pattern that can be identified mathematically. Through a data track system, computer-developed winding patterns can be produced with extreme accuracy, under completely controlled environmental conditions.

Included in the new facilities are winding machines for smaller structures, and large presses for molding rubber and plastic insulators. All associated materials control, curing, finishing, inspection, and testing are likewise provided in the new plant.

B.F.Goodrich offers a complete capability—we can help you in designing and producing light, strong, heat-resistant structures. For information contact *Department MR-3, B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Akron, Ohio.*



Filament wound rocket motor case

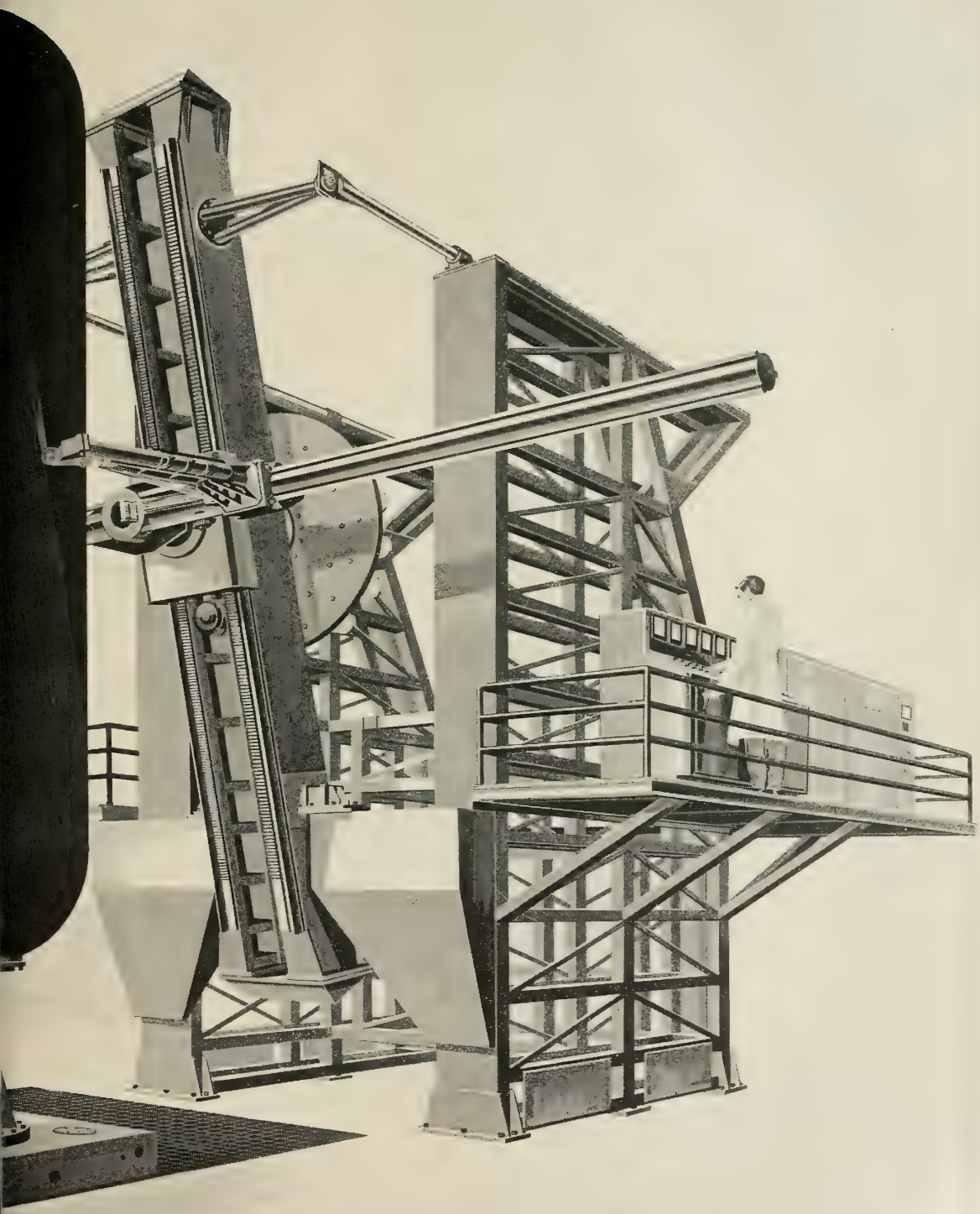


Rubber insulators for motor cases



B.F.Goodrich

aerospace and defense products



Circle No. 32 on Subscriber Service Card

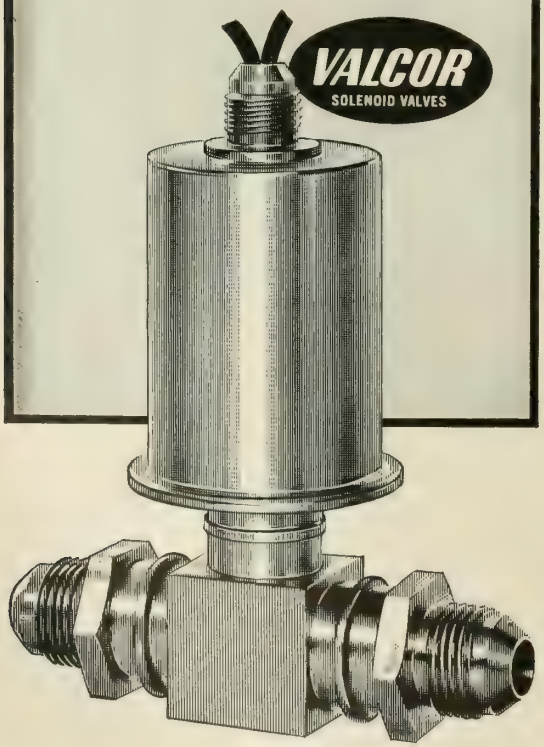
A solenoid valve that operates at −423° F or 1000° F

Valcor's engineers originally designed this solenoid valve, of series 412, to operate completely submerged in liquid hydrogen (—423°F). The unique application required a valve that would eliminate the use of any non-metallic parts coming in contact with the media, internal or external. All materials had to be critically analyzed because of the destructive forces inherent in such extreme temperatures.

The all welded construction, which Valcor has developed to a new state-of-the-art, helped resolve many of the problems. During the exhaustive series of tests, it was known that many of the problems in operating a solenoid valve under the extremes of low temperature had a correlation to problems created by high temperatures. The result — a **one** valve concept that with minor variations could be used for high or low temperatures...

Another reason why Valcor precision engineered valves are chosen for so many aero-space vehicles.

Write today for your copy of Valcor's catalog, "Valve Selections For Aero-Space Applications".



VALCOR ENGINEERING CORP.

5362 CARNEGIE AVE., KENILWORTH, N. J., CH 5-1665 (AREA CODE 201)

Circle No. 33 on Subscriber Service Card

—contracts and procurements—

AWARDS

AIR FORCE

$34,000,000—**Martin Marietta Corp.,** Baltimore, for continued installation and checkout of *Titan II* missiles. Work to be done at Tucson, Ariz.; Wichita, Kan., and Little Rock, Ark.

$16,400,000—**General Cable Corp.,** Bonham, Tex., for *Minuteman* intersite cable production and installation at Warren AFB, Wyo.

$7,100,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued *Titan II* propulsion systems work.

$5,667,000—**Mitre Corp.,** Bedford, Mass., for systems engineering and technical development of command and control systems (supplemental contract).

$4,326,678—**Aerospace Corp.,** Los Angeles, for general systems engineering and technical direction of ballistic missile and space programs (supplemental contract). Work to be done at El Segundo, Calif.

$3,933,914—**System Development Corp.,** Santa Monica, Calif., for development and preparation of system training programs (supplemental contract).

$3,800,000—**North American Aviation, Inc.,** Downey, Calif., for *Minuteman* guidance/control system spare parts.

$3,450,000—**Massachusetts Institute of Technology's Lincoln Laboratory,** Cambridge, for research and development in the national defense, jointly sponsored by the Air Force, the Army, the Navy and the Advanced Research Projects Agency of Dept. of Defense.

$3,000,000—**Space Technology Laboratories, Inc.,** Redondo Beach, Calif., for ballistic missile systems engineering and technical direction.

$2,500,000—**General Dynamics Corp.,** San Diego, for design and development of a standard space launch vehicle.

$2,180,445—**Reynolds Metals Co.,** Richmond, Va., for production of electronic countermeasures material.

$1,750,000—**Sylvania Electric Products, Inc.,** New York City, for follow-on research and development for production of security subsystems for *Minuteman* missile bases. Work to be done at Mountain View, Calif.

$330,000—**General Dynamics/Convair,** San Diego, for follow-on work on *Minuteman* guidance housing assemblies.

ARMY

$2,000,000—**Control Data Corp.,** Minneapolis, for electronics equipment. Work to be done at Minneapolis and Los Angeles.

NAVY

$6,900,000—**Bendix Corp.,** Detroit, for *Talos* missile guidance control and airframe.

$3,000,000—**Bendix Corp.'s Mishawaka, Ind., Div.,** for continuing research and development on long-range *Typhon* missile system.

$2,305,163—**Lasko Metal Products, Inc.,** Westchester, Pa., for rocket launchers for *Zuni* rockets.

$2,300,000—**Lockley Machine Co.,** for production of *Zuni* rocket launchers. Work to be done at New Kensington, Pa., Youngstown, Ohio, and New Castle, Pa.

$1,200,000—**Avco Corp.,** New York City, for *Polaris* arming and fuzing devices. Work to be done at Richmond, Ind.

$1,200,000—**Elgin Watch Co.,** Elgin, Ill., for *Bullpup* missile fuzes. Work to be done at Los Angeles.

$889,943—**Vitro Corp. of America's Vitro Laboratories Div.,** Silver Spring, Md., for engineering services on *Terrier, Tartar, Talos* and *Typhon* guided missile weapons systems.

$597,000—ARINC **Research Corp.,** Washington, D. C., for reliability engineering assistance to the U. S. Naval Ordnance Test Station, China Lake, Calif.

NASA

$9,700,000—**Paul Hardemann, Inc.,** Los Angeles, for construction of two test stands and a control center for the *Saturn* project at the Mississippi Test Facility.

$1,500,000—**Dalmo Victor Co.,** Belmont, Calif., for development and manufacture of satellite automatic tracking antenna systems.

$189,000—**Martin Co.,** Baltimore, for a study of power systems for Earth satellites.

Hazeltine Corp., Little Neck, N. Y., for development of a day-night TV camera for Goddard Space Flight Center and the *Nimbus* meteorological satellite (undisclosed amount).

INDUSTRY

$3,000,000—**Fairchild Stratos' Aircraft-Missiles Div.,** Hagerstown, Md., from **Bendix Corp.'s Mishawaka Div.,** for airframe components for the *Talos* missile program.

$1,600,000—**Control Data's Marketing Div.,** Minneapolis, from the **Douglas Aircraft Co.,** for five Control Data 924-A computer systems for use in the *Saturn* vehicle project.

$500,000-**Swedlow, Inc.,** Los Angeles, from **Aerojet-General Corp.,** for an undisclosed number of reinforced plastic nozzle components for the *Minuteman* missile.

a baker's dozen

you get an "extra" at b&p

Just as your neighborhood baker gives you that *extra* so does B&P. Our *extra* is available to you in our *capability* and *experience* with lightweight and space age metals. May we have the opportunity to work with you?



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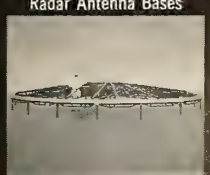


Aerial Delivery Systems
Armament Training Pods



Missile Nose Cones
Radar Antenna Bases





62-DP-4

Circle No. 34 on Subscriber Service Card

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For Missile Designers and Manufacturers

In any language the Greeks had a word for it — DEPENDABILITY. At *Telerad,* we believe in stressing those factors that will establish us in your mind as a truly dependable source. A dependability that's built on creative research . . . on rigid electrical and mechanical testing as the standard for quality control . . . on our being customer-minded so that you get precisely what you require — and on time, too. ■ A small reflection of *Telerad's* capabilities are these recent airborne transponder beacon developments (C and X Band types). Besides the usual applications there is a substantial variety of ground to air or air to air conversions possible through *Telerad* "imagineering." ■ Whatever your field of interest — systems or component engineering, research and development or straight purchasing of standard components — don't you think it would be a good idea to try us at *Telerad* next time?



FROM AN ESTABLISHED SOURCE

TELERAD

A DIVISION OF [illegible] CORPORATION

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Circle No. 35 on Subscriber Service Card

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Tex.

Engineering, design, fabrication and testing of a special gas test chamber, 60 in. wide x 40 in. deep x 72 in. high, to be used for testing and evaluating spacecraft gas analysis systems, and evaluating components and systems for compatibility with explosive mixtures such as oxygen and hydrogen. RFP MSC 63-344P. RFP due date 4-11-63.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

NASA is negotiating with Watts Engineering Sales, 1741 Reese St., Birmingham, Ala., for actuators, rotary hydraulic, Flo-tork Corp. model 75-000A. Specs in accordance with NASA drawing C75M-05106L—2 each. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor. No proposals are available.

U. S. Navy Dept.
Bureau of Ships
Washington 25, D. C.

The Bureau of Ships under RFP 743A-30383(S) is soliciting a proposal from Vitro Laboratories, Silver Spring, Md., for preparation of training materials and conduct of a training course and guided missile launching system, MK9. Vitro Laboratories is considered to be the only firm in a position to meet urgent requirement of this procurement. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

U. S. Army Missile Support Command
Redstone Arsenal, Ala.

Pershing repair parts—various quantities. Schaevitz Engineering has been selected without competition because they are fabricating the end item and it would not be economical to develop other sources for these small quantities of concurrent repair parts. Schaevitz Engineering is the only known source with the technical knowledge and facilities capable of delivering the items within the required time. This synopsis is to publicize subcontracting opportunities and all inquiries must be referred to Schaevitz Engineering, U. S. Route 130 and Union Avenue, Pennsauken, N. J.

National Aeronautics and Space Administration
Goddard Space Flight Center
Glendale Road
Greenbelt, Md.

Construction of an anechoic chamber building located on the Agricultural Research Center site, Greenbelt, Md. Job—IFB SC-26. Bid opening 4-4-63. Deposit for plans and specs in the amount of $25.00 per set is required in certified check or money order made payable to NASA. Distribution of plans and specs limited to prime or general contractors only and shall not exceed three sets each until supply is exhausted. Address requests to NASA, Goddard Space Flight Center, Greenbelt, Md. Attn: Donald Menard, Code 242.

Secondary Items Branch
Procurement Div.
Procurement and Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

Wing panel, outer, guided missile, FSN 1420-787-7349, OPN 9080450—150 each. Delivery to be completed by May, 1963. Negotiations will be limited to Nortronics, a division of Northrop Corp., 500 E. Orangethorpe Ave., Anaheim, Calif., the manufacturer of the above part. Notice is given that available specs or drawings relative to the procurement described above do not provide all necessary manufacturing details. U. S. Army Missile Command Req. Order No. D132369801D1AB. This synopsis is to publicize subcontracting opportunities. Contact Nortronics for any additional data

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U. S. Army Missile Command
Directorate of Procurement and Production
Goco Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXG

Selected source procurement for Thiokol Chemical Corp., Alpha Div., Huntsville Plant, Huntsville, Ala., for the fabrication and delivery of XM3326 rocket motors for NASA—2 each. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor. No proposals are available.

Selected source procurement for Thiokol Chemical Corp., Alpha Div., Huntsville Plant, for a continuation of design and fabrication in support of the liquid propellant research program. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor. No proposals are available.

Selected source procurement for Rohm & Haas Co., Redstone Research Div., Huntsville, Ala., for a continuation of a research and experimental program for the evaluation of encapsulated propellant materials. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor. No proposals are available.

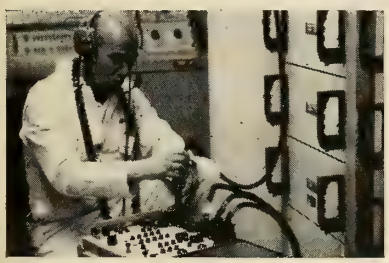






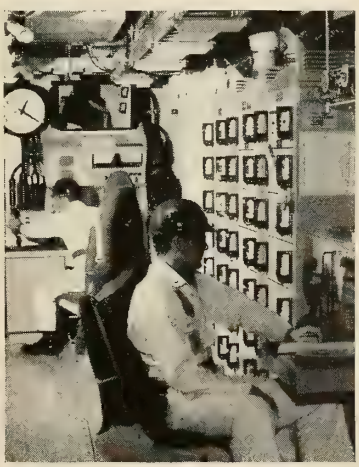
MINUTEMAN, U.S. Air Force's solid-fuel ICBM, is now operational at Malmstrom AFB, Montana. Missiles, after assembly in a Boeing-operated plant, are delivered to sites and lowered into silos (above left and center), for link-up with support and launch-control equipment. Picture, right above, shows earlier test firing from Cape Canaveral. The Minuteman program, on which Boeing is weapon system integrator, has achieved success unprecedented in the history of intercontinental missiles, in terms of low-cost missile production, economical maintenance and operation, and ahead-of-schedule performance from drawing board to final installation.

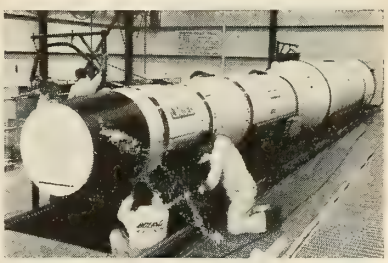
Capability has many faces at Boeing



WEAPON system, comprising Minuteman missiles and their electronic launch-control and support equipment, are assembled at operational sites by Boeing technicians.

STRATEGIC Air Command officers, right, man operational Minuteman underground launch-control center at Malmstrom Air Force Base. Boeing assists the Air Force in combat crew training prior to operational assignment.





THREE engines, plus interstage structures and missile skirts are assembled into Minuteman missiles and inspected (above) at Boeing-operated facility adjacent to Hill AFB, Utah.

BOEING

AERO-SPACE DIVISION

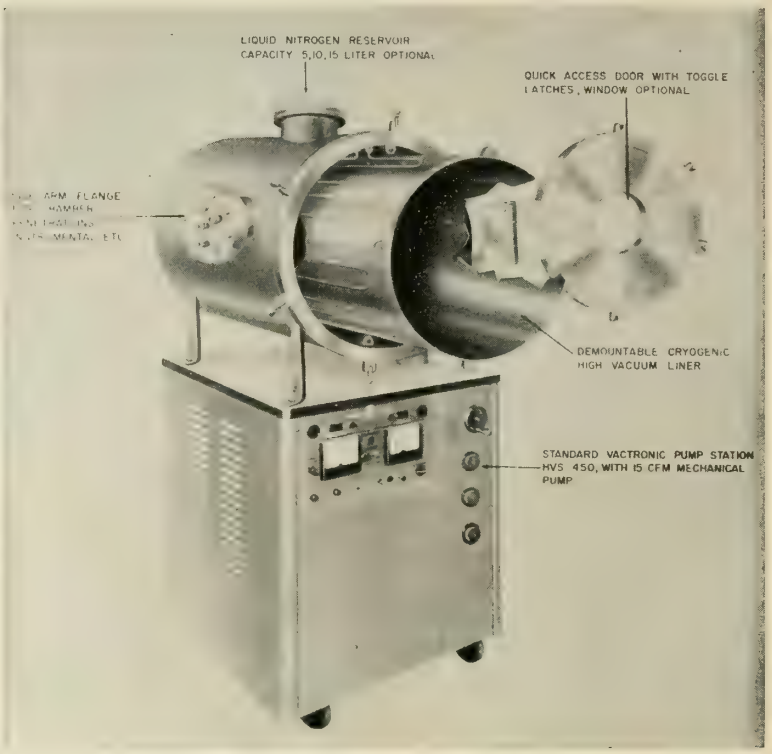
Countdown on
FENN
Completeness
for the Manufacture of
Your Aerospace Components

EXPERIENCE	Over 60 years of precision metalworking
ENGINEERING	Tool and process group
FLEXIBILITY	From prototypes to quantity production
REPUTATION	Dependability and performance
SIZE OF BUSINESS	Small—450 employees
PLANT	Ultra modern—150,000 sq. ft.
LATHES	Engine, turret (chucking), vertical turret, tracer
GRINDING	Surface, internal, thread, cylindrical, honing
MILLING & PLANING	Vertical spindle, thread, horizontal, hydrotel, planer
DRILLING	Radial, sensitive, deep hole, tapping, P&W Tape-O-Matic
BORING	Includes 3E P&W jig borer and 3B Devlieg
GEAR CUTTING	All aircraft gears
HEAT TREATING	Most modern equipment
PLATING & SURFACING	Anti-corrosion finishing to certified government specifications
METALLURGICAL LABORATORY	Physical and chemical inspection
METALLURGICAL X-RAY	GE industrial unit OX-250-KVP
QUALITY CONTROL	Air Force, Navy, F.A.A. approved, Resident Air Force inspection

AEROSPACE PRODUCTS DIVISION

Write for facilities brochure and list of principal equipment

THE FENN MANUFACTURING COMPANY
Newington, Connecticut
Circle No. 36 on Subscriber Service Card



New Product of the Week: Compact Space Simulation Chamber

A laboratory size space simulation chamber for environmental testing has been developed by Vactronics Lab. Equipment Inc.

Basically designed as a multi-purpose high-vacuum system, the unit is used for in-plant testing of materials, components and sub-assemblies, in order to determine their adaptability to extreme temperatures and vacuum conditions encountered in a space environment.

The Model #ETC-450 incorporates a Vactronic standard pumping station. The unit has a pump-down time to $2x10^{-6}$ mm of Hg in 10 minutes with low 10-8 ultimates, and handles temperatures from −320°F to 600°F.

Circle No. 225 on Subscriber Service Card

Radiation Shielding Material

A ceramic that provides a wide spectrum of radiation shielding for use in a variety of building materials has been acquired by American Brands Corp. Called Polyshield, it is compounded to afford excellent gamma and neutron shielding properties, as well as X-ray and nuclear particle shielding. It is manufactured as a dry solid in granular or powdered form; and can be molded or formed in thermal or cold-setting materials.

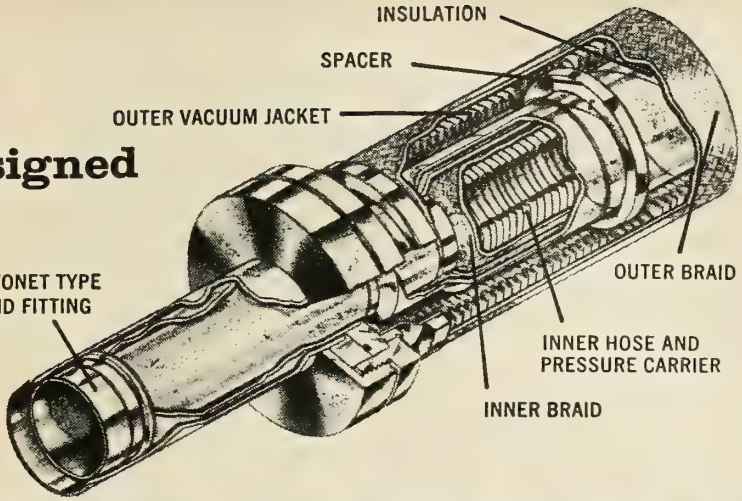
Polyshield can be used in plastics to as much as 80% quantity by weight without introducing sensitivity to water, temperature or environment. It often improves the structural integrity and/or nuclear stability of the plastics. To date, Polyshield has been used in the following plastics: soft (polyethelene) foam (polyurethane), and hard (epoxies and polystyrene).

Polyshield boasts a short half-life, and it also permits the construction of reactor and high-energy particle shields incapable of becoming "permanently" radioactive.

Circle No. 226 on Subscriber Service Card

Potentiometer

The A. W. Haydon Co. is marketing a potentiometer drive with digital indicator, which is designed for use in a control computer system. This unit furnishes a linear resistance change of the pot proportional to the duration of motor operation. The pot position can be read instantly from a three-digit



DK designed

CRYOGENIC transfer LINES

DK manufactured vacuum jacketed cryogenic lines have exceptionally low heat exchange!

Take a close look at the design and construction of the vacuum jacketed transfer line shown here. You'll quickly see why it answers the problem of transferring costly cryogenic materials most adequately!

- Cryogenic Storage and Transfer Devices: Containers, Hose, Ducting, Piping
- Pressure Vessels: Titanium, Stainless, Steel, Inconel, Monel, Aluminum, Copper
- Certified LOX Cleaning Facilities
- Certified Testing Facilities
- Complete Fabricating Facilities
- Approved Quality Control

DK has combined experience, design capability and advanced manufacturing technique into producing a wide selection of vacuum jacketed transfer lines constructed of flexible metal tubing, rigid tubing and vacuum jacketed gimbals in many combinations. These cryogenic lines are finding diverse applications in Airborne as well as G.S.E. service. Available in standard sizes or in special designs to meet special needs.

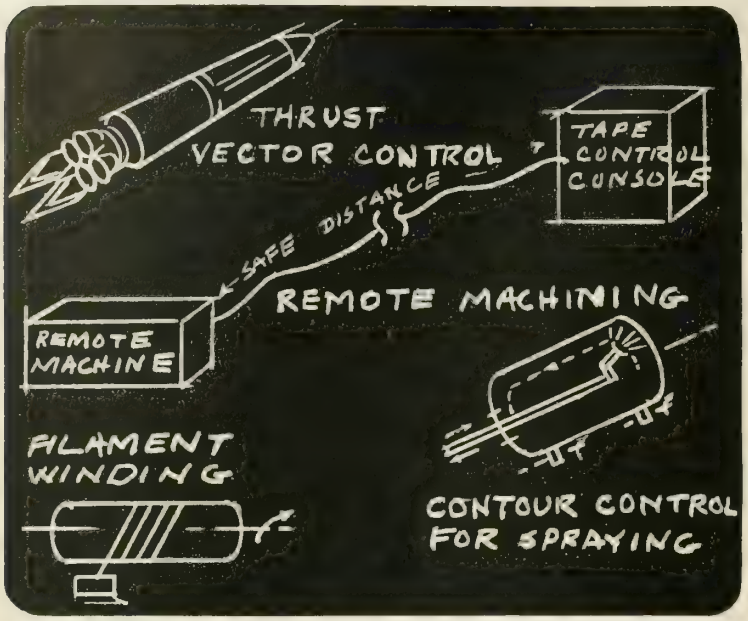
Our new brochure has complete information including test data. Write, wire or phone for a copy today. Ask about "vacuum jacketed cryogenic transfer lines."

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5059 South Kedzie Avenue • Chicago 32, Illinois
DUNBAR KAPPLE DIVISION
North Island Avenue • Batavia, Illinois

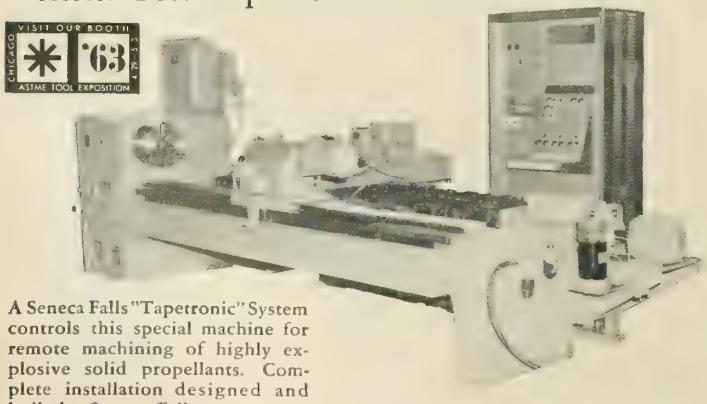
280A

Circle No. 37 on Subscriber Service Card

WHAT'S YOUR PROBLEM



SENECA FALLS ELECTRONICS DIVISION has developed and produced many interesting innovations in the field of control systems and control components which have solved a number of unusual control problems in diverse areas of application. Backed by 99 years of machine tool building experience, the Electronics Division is in an excellent position to assist with any problem involving controls and/or the automation of machines, equipment and processes. Your inquiries are invited.



A Seneca Falls "Tapetronic" System controls this special machine for remote machining of highly explosive solid propellants. Complete installation designed and built by Seneca Falls.

SFM PIONEERS IN AUTOMATION

ELECTRONICS DIVISION
Seneca Falls Machine Co., Seneca Falls, N.Y.

Circle No. 38 on Subscriber Service Card

counter in one-thousandth turn increments before repeat. A printed circuit limit switch de-energizes the motor when the potentiometer arm reaches either end of its travel. Then the motor can be reversed whenever desired through external switching.

Circle No. 227 on Subscriber Service Card

Double-Pulse Generator

A radar double-pulse generator, Model 1400, which can produce single or double pulses with amplitudes to 200v negative or 60v positive, has been developed by Marconi Instruments.

For use in radar, television and nucleonics, where high pulse amplitude and multi-variable outputs are desirable, Model 1400 will produce pulses with lengths variable from 0.1 μsec. 100 μsec, and 30-nonosecond rise time.

With the plug-in, TM6600, a third pulse is obtainable having an independently variable width and relay. This third pulse also triggers the second pulse at the main pulse output.

Circle No. 228 on Subscriber Service Card

Nanosecond Delay Network

Spencer-Kennedy Laboratories, Inc, offers the Model 505 Nanosecond Delay Network, designed to provide a convenient means of adjusting the relative timing between two pulses in the nanosecond region.

The unit provides a 100-nanosecond delay of very high quality for the main pulse. A variable trigger delay, selected by a front panel switch, provides pulses at 5-nanosecond intervals between a minimum of 5 nanoseconds and a maximum of 160 nanoseconds. An inverting transformer allows for changes in trigger polarity without affecting the main pulse. Impedance is 50 ohms.

Circle No. 229 on Subscriber Service Card

Cryogenic Valves

A series of pilot-operated pneumatic-solenoid valves for both high-temperature and cryogenic service with 5250-psi-rated proof-pressure and high-flow capacity has been developed by Calmec Mfg. Corp.

Produced in standard ¼-in. through 1½-in. tube sizes, Series 400 valves are available with stainless steel or aluminum bodies in three temperature ranges: —420° F to 200° F; —65° to 200° F; and —65° to 600° F. The solenoid operates at 18 to 3v d-c with 30-60-millisecond response time over a 100-3500 psi range; 115v a-c operation is also available.

Circle No. 230 on Subscriber Service Card

Silicon Diode

A type of silicon diode, one that turns off in the time it takes light to travel 1.5 in. has been developed by

NEW CENTER FOR ADVANCED SYSTEMS DEVELOPMENT

This modern engineering center in Farmington, Connecticut is now the focal point for a wide variety of programs that range from weather systems to systems for anti-submarine warfare. Here have been consolidated all research, analysis, planning and engineering as well as a complex of supporting services.

One important effort is the design and development of a highly-sophisticated stellar inertial guidance system for navigation in outer space. Aided by an outstanding guidance and control simulation laboratory and a computer installation with real-time simulation capability, significant progress has already been made.

In anticipation of further advancements, we are interested in contacting engineers at both senior and intermediate levels. Salaries are excellent as are living conditions and opportunities for reimbursed graduate study.

You are invited to send your resume to Mr. L. W. Abbey, UAC Corporate Systems Center, 1690 New Britain Avenue, Farmington, Connecticut — an equal opportunity employer.



ADVANCED PROGRAMS IN Stellar Inertial Guidance • Bioscience • Naval Systems Analysis • Weather Systems • Missile Design • Advanced Systems Research • Reconnaissance and Intelligence • Space Sciences • Electronic Technologies • Conceptual Design • Weapons Systems

United Aircraft
CORPORATE SYSTEMS CENTER

Circle No. 39 on Subscriber Service Card

the General Electric Co.

The four types currently in production are rated at 250 mw power dissipation at a case temperature of 25°C, and have a 1 microsecond peak surge current rating of 2 amperes. The devices are being produced in the JEDEC standard DO-7 package.

Typical turn-off time for types SSA550 and SSA551 is 0.3 nanoseconds, for types SSA552 and SSA553 0.2 nanoseconds.

Circle No. 231 on Subscriber Service Card

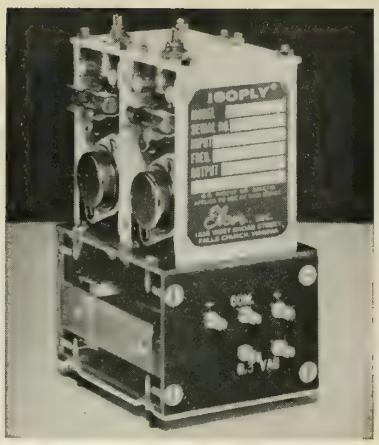
Digital Events Recorder

The Scientific Data Systems digital events recorder, Model DEE-1, samples up to 1534 on-off control lines and records changes as they occur, with the time of occurence to the nearest millisecond. The sampling rate is 400 lines every two milliseconds. All components in the DEE-1 are solid-state and silicon semiconductors are used exclusively. The system will operate at from 0° to 55°C.

Circle No. 232 on Subscriber Service Card

Dual Isoply

Designed for use with stabilized differential amplifiers such as the Epsco wide band DC amplifier ADS-1, a dual



output isolated power supply with a chopper drive output has been developed by Elcor, Inc. The Model 124-EI Isoply® offers an extremely low shunt capacitance of 25 pf and a very high leakage resistance of more than 100,000 megohms at the output. These characteristics are ideally suited for powering an amplifier to be used as a buffer or in the potentiometric mode.

The outputs are a positive and negative 18 VDC, an unregulated center tapped 6.3 VAC. This modular unit maintains 0.2% line and load regulation. Engineered circuit design and patented shielding techniques make possible a hum- and noise-reduction to less than 10 microvolts RMS per kilohm impedance to ground.

Circle No. 233 on Subscriber Service Card

Multiaperture Ferrite Cores

The Motorola Solid State Systems Division has developed multiaperture ferrite logic (MAFL) cores.

The technique permits fabrication of nearly any core configuration in small quantities at a fraction of the cost of the old die-press method. MAFL cores are used in digital control systems, involving shift registers, counters, A to D converters, encoders, decoders, and other digital modules. They are unaffected by overloads and not greatly affected by electromagnetic and nuclear radiations.

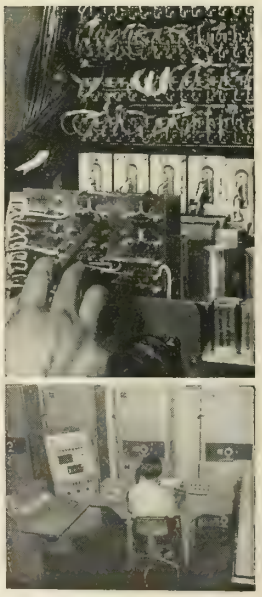
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Regulated Power Supplies

Designed for applications requiring a high degree of stability and reproducibility, 100- and 200-ampere solid-state, precision regulated-voltage/current power supplies with guaranteed regulation up to one part in 100,000 or better, are available from Alpha Sci-

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TESTING *...simulation of space environments and weapon system mission profiles, electronic ordnance and cryogenic parts and systems testing.*

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UNITED TESTING LABORATORIES *a division of United ElectroDynamics, Inc.*

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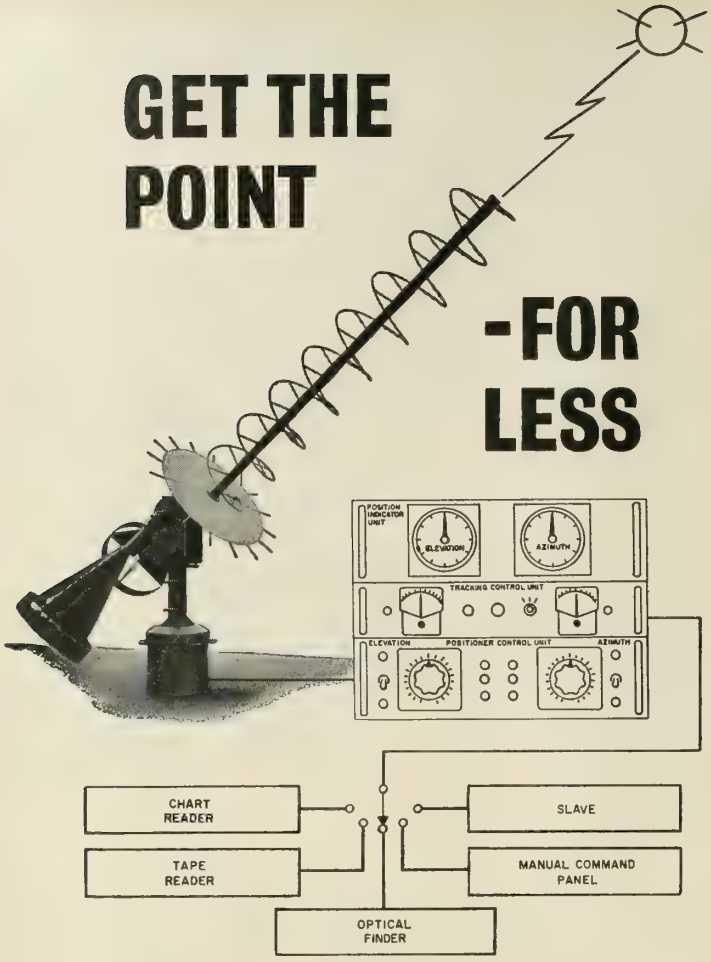


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GET THE POINT -FOR LESS



Scientific-Atlanta telemetry antenna position systems offer a unique, economical answer to the problem of following satellites, missiles, aircraft or astronomical targets with medium gain antennas. Such systems provide tracking rates of 6 degrees per second or higher and pointing errors of no more than 3 degrees. Yet, these systems are modestly priced at less than $10,000.

The two-axis antenna pedestals are "militarized" versions of standard Scientific-Atlanta antenna pattern range positioners, giving an extra margin of reliability even beyond the proven performance of these mounts. Control is provided by Scientific-Atlanta's augmented manual tracking equipment.

Features include two-axis tracking from programmed or slaved sources as well as manual control and continuous position indication; accessories such as optical finders, tape readers, chart readers, manual position command panel, and other input devices; use of solid state units for reliability and compactness (complete control/indication systems in 14″ of rack space) and integration of standard Scientific-Atlanta instrumentation wherever possible throughout the system.

Rugged and reliable, these systems meet the environmental requirements of MIL-E-4158 and the RFI shielding requirement of MIL-I-26600.

We invite your request for more information. Please address Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta 24, Georgia. Phone: (404) 938-2930.

SA **SCIENTIFIC-ATLANTA, INC.**

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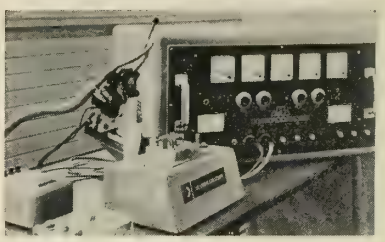
entific Laboratories. Operation as either a regulated-current or regulated-voltage source is selectable by means of a single switch. Line voltage operation from either 115v or 220v is available as an option.

The characteristics of these supplies permit them to be used for precisely stabilized current sources for solenoids and electromagnets in nuclear magnetic resonance, electron paramagnetic resonance and plasma experiments.

Circle No. 235 on Subscriber Service Card

Balancing Machine

A two-plane electronic-dynamic balancing machine for balancing gyroscopes has been developed by American Hofmann Corp. The unit measures the extent of imbalance as a function of displacement between the center of gravity axis and the axis of rotation. Both the



angle and amount of imbalance are separately displaced on large, easy to read dials. The machine is accurate to 0.0000004-in. displacement.

The gyroscope weighs approximately 18 grams and can be balanced at speeds up to 36,000 rpm.

Circle No. 236 on Subscriber Service Card

Thin-Film Vacuum Coater

A vacuum coater for thin film production has been developed by NRC Equipment Corp. The Model 3176 has a vacuum performance capability of 10^{-7} to 10^{-8} torr operation. Major uses for the coater are: solid-state and fundamental research, thin-film electronics production and development, and optical devices manufacture.

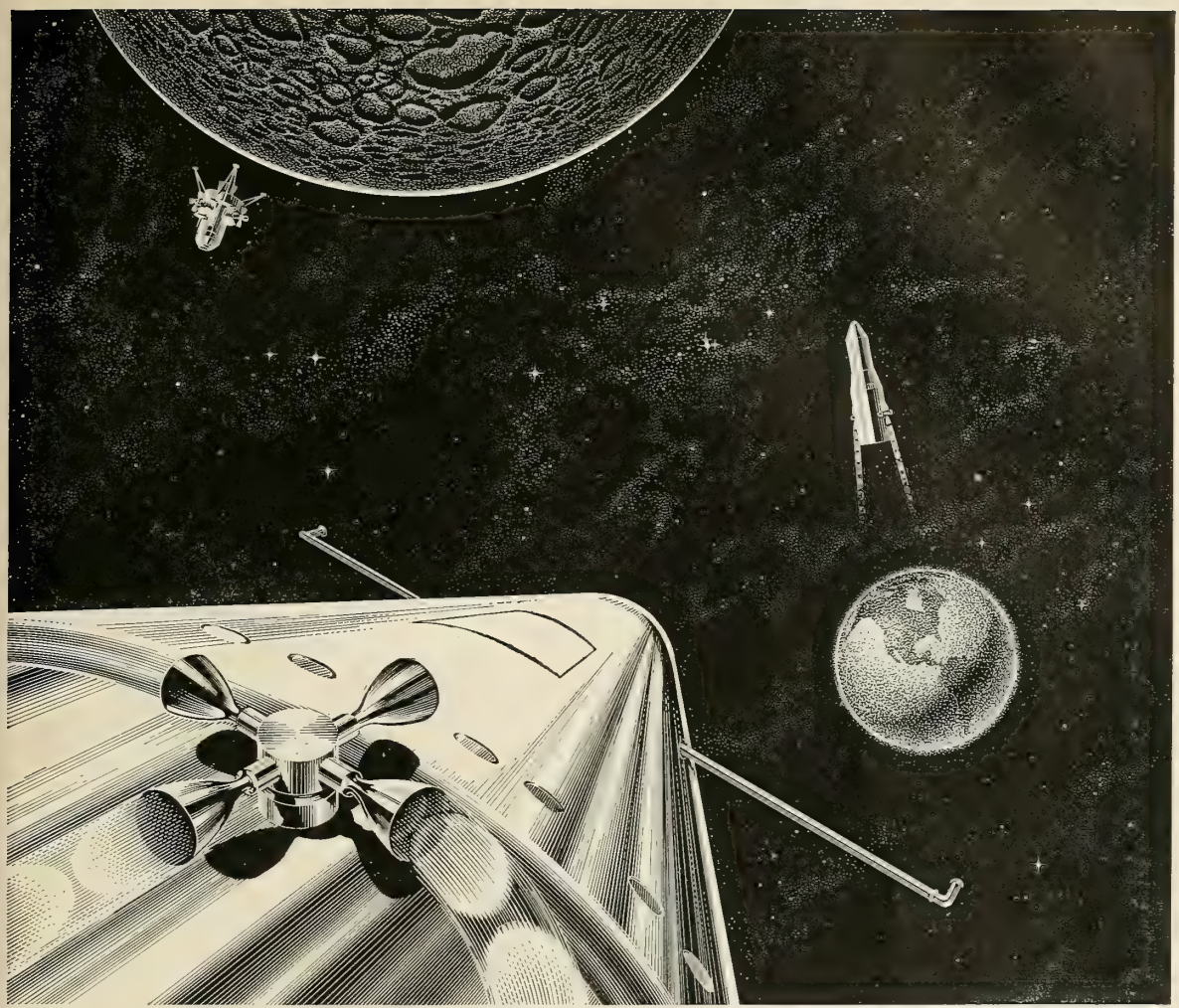
Circle No. 237 on Subscriber Service Card

Rectifier Bridges

Two series of "Powercomb" molded, full-wave, single-phase rectifier bridges are available from Power Components, Inc.

The 2B bridges are comprised of four avalanche-type silicon rectifiers specially selected for this application. The bridges are rated at 2 amperes at 50°C with linear derating to 1.25 amperes at 100°C. PIVs range from 50 volts to 2,000 volts per leg.

The high-voltage HVB bridges range



New rocketry employment opportunities at Marquardt

Marquardt engineers have made significant technological contributions toward the development of precisely controlled rocket systems as the result of company-sponsored efforts initiated in 1958. Within a four-year period, these advances have made Marquardt a recognized leader in the reaction controls field. During the past twelve months, the Company has been awarded contracts on some of the Nation's most advanced space programs, creating exceptional opportunities for imaginative and experienced engineers and scientists.

These programs include:

Project Apollo Service Module—reaction control rockets
Saturn IV B—ullage rocket engines
Syncom II satellite—reaction control system

Ground-floor opportunities are also developing as a result of negotiations on reaction control system components for the Apollo Lunar Excursion Module, continuing company-sponsored research and state-of-the-art contract activity.

As a producer of sophisticated reaction control rocket systems—expulsion systems, combustion chambers, valves, nozzles and support equipment—Marquardt offers an outstanding climate for advancement to engineers and scientists who want to develop professionally through association with a dynamic company well diversified in rocketry, electronics, airbreathing propulsion, and aerospace research.

The Power Systems Division, the organization at Marquardt most directly concerned with rocket control and propulsion systems, has immediate openings for men with significant experience—engineers who have a demonstrated technical capability. If you hold a B.S., M.S., or Ph.D. in Mechanical Engineering, Aeronautical Engineering, Physics, or Nucleonics, and possess an engineering background in *rocket motors and control systems, airbreathing propulsion, mechanical controls, propulsion cycle analysis, aerodynamic development, test instrumentation, or test operations,* you are invited to send your resume, in confidence to Mr. Floyd Hargiss, Manager, Professional Personnel, 16555 Saticoy Street, Van Nuys, California. Marquardt, an equal opportunity employer, is dedicated to keeping the United States first in technology.

THE MARQUARDT CORPORATION

from 2,000 to 50,000 volts PIV per leg, are comprised of selected and matched 1E10 "Powercomb" E avalanche-type rectifiers. Current ratings at 50°C vary from 1½ amperes at 2,000 volts to 500 ma for the 50,000-volt unit. At 100°C, the range of current ratings is from 1 ampere at 2,000 volts to 300 ma at 50,000 volts.

Circle No. 238 on Subscriber Service Card

Automatic Cable Tester

American Electronic Laboratories, Inc. is marketing the Model 238 automatic cable tester, which uses solid-state measuring and driving circuits. This portable unit will check up to 126 conductors, including six coax cables, in rapid sequence (approximately 60 to 70 seconds).

Having many applications in industries as communications, missile, electronics, etc. the unit will automatically or manually test for shorted or transposed conductors, measure conductor resistance, provide insulation resistance tests up to 1000v d-c, and test for RF attenuation up to 100 db. The tester is supplied with a test module that permits the unit to check itself for proper operation.

Circle No. 239 on Subscriber Service Card

Heating Generator

Developed by Lepel High Frequency Laboratories, Inc. the Model T 5-3 is an electronic tube generator with a power output of 5 kw. Two separate interchangeable tank circuits are available for conversion from kilocycle frequency (250 to 600kc) to megacycle frequency operation (2 to 10 mc) in 20 min. For the oscillator power supply, there is a choice of solid-state rectifiers, thyratron tubes or rectifier tubes. The power can be controlled by either the thyratron control, saturable reactor control, or the variable transformer control. An automatic timer is incorporated into the unit for setting pre-determined heating cycles.

Circle No. 240 on Subscriber Service Card

Fast Loop Controller

Critical temperature problems requiring extremely accurate control are the application areas of a high-speed, solid-state 3-mode electronic controller, developed by Honeywell.

The potentiometric measuring and controlling device, which has no moving mechanical parts, can be applied to high-temperature processes having a measurement "lag" of 10 sec. or less and needing a proportional band (throttling) range of 600 microvolts or less.



Sensitivity of the controller is such that a 0.5-microvolt change in input results in control response. At 2500°F, using a Type R thermocouple, the temperature change could be 0.08°F. Controller stability is less than three microvolt shift (referred to input) over a three-month period under normal operating conditions.

Circle No. 241 on Subscriber Service Card

Vacuum Control Gage

Nuclear Corp. of America has available a cold cathode gage/control. Pro-



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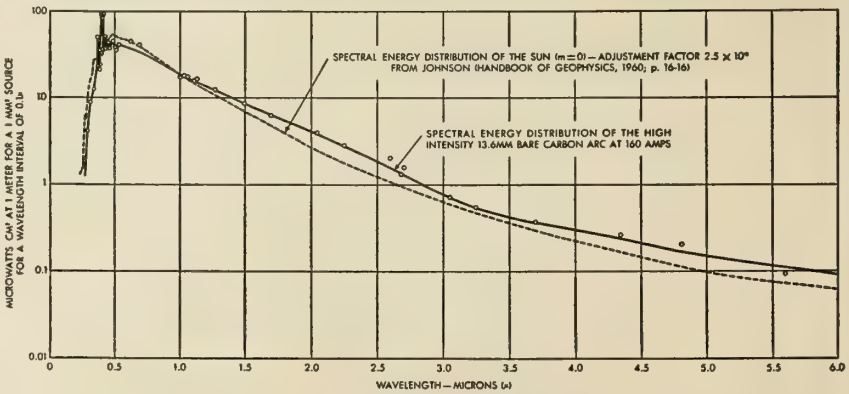
The nearest man-made approximation to solar radiation is the carbon arc!

No other light source provides the radiant intensity and spectral distribution so necessary to dependable space simulation . . . for environmental testing of space vehicles and components and calibration of solar cells.

Whatever your light-source problem in solar simulation, contact National Carbon Company.

SOLAR SIMULATION

needs spectral quality of carbon arc...



HERE'S PROOF! The above chart illustrates the excellent match of the bare 13.6mm carbon arc spectrum and the solar spectrum as encountered above the earth's atmosphere. For comprehensive data, request a copy of "Studies in the Spectral Energy Distribution of Different Light Sources in Connection With Solar Simulation," a report from National Carbon's Development Laboratories.

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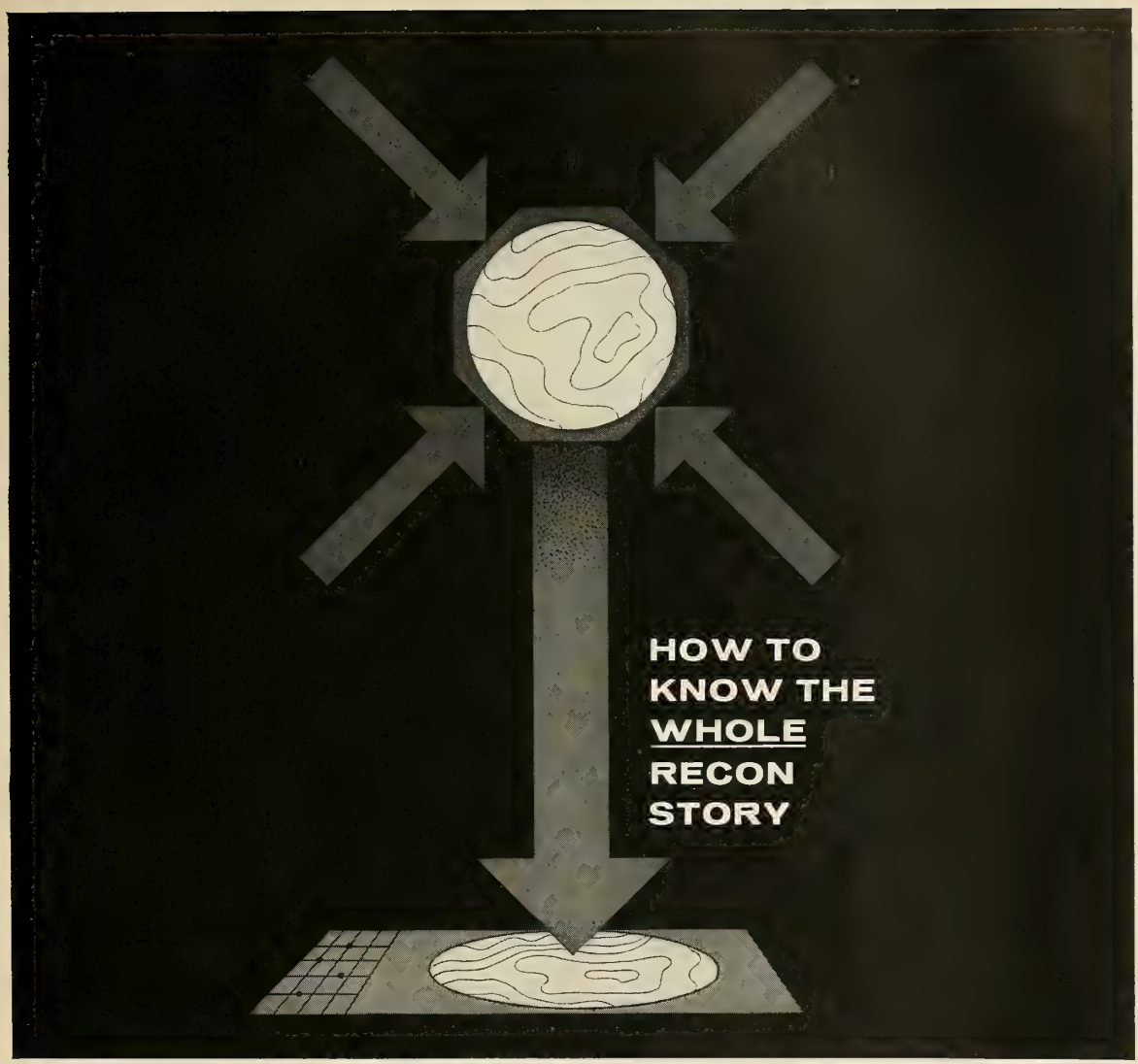
NATIONAL CARBON COMPANY

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In Canada: Union Carbide Canada Limited, Toronto

UNION CARBIDE

Circle No. 44 on Subscriber Service Card



High resolution photos are just part of the reconnaissance job. Photos must also be tied-in precisely to geography and numerous other critical conditions that surround surveillance from high-performance aircraft. Through this match, the whole recon story begins to take shape. To handle the important job of high-speed data annotation in flight, Fairchild Stratos has developed compact, light-weight computation and display devices which provide permanent data records on each image in easily read alpha-numeric format. When coupled to Fairchild Stratos data link, the "whole" recon story can be remotely viewed in "real time". High speed annotation techniques are but one outgrowth of the years of experience that have made Fairchild Stratos the leading supplier of equipment for reconnaissance and surveillance needs. For more information, contact our Director of Customer Relations.

When there's a need to know: Fairchild Stratos-Electronic Systems Division capabilities are best reflected in an integrated approach to data requirements. Extensive experience in acquisition, processing, transmission and display has given FS-ESD engineers a particularly sensitive awareness of both final information needs and the many subsystems required to answer them. • *For knowledgeable engineers interested in career opportunities in advanced data techniques, may we suggest a note to our Director of Industrial Relations for the brochure "Grow Your Own Future". FS-ESD, an equal opportunity employer.*

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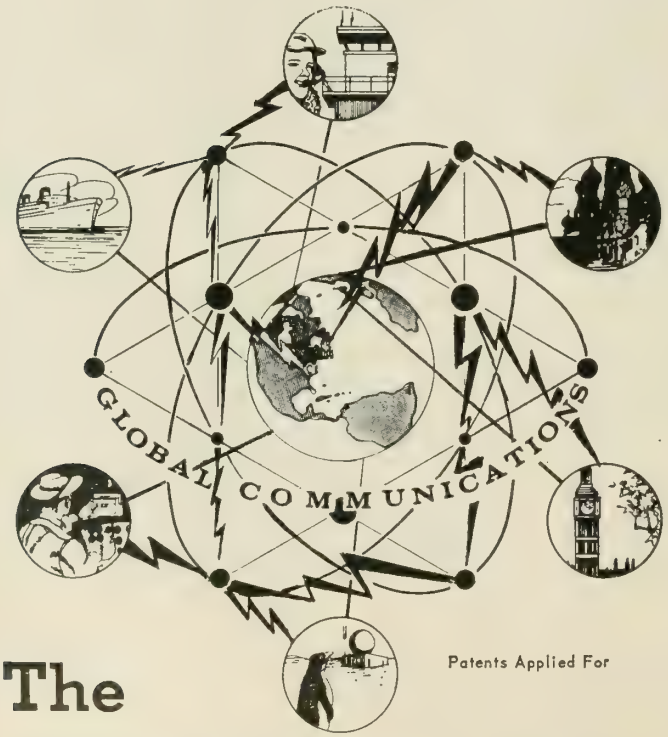
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Circle No. 46 on Subscriber Service Card

viding measurements of vacuum from 25 microns to 1 x 10^{-7} torr on three color-coded ranges, Model 2641 is used for obtaining accurate and reproducible readings over this range.

Operation of the unit is based on measuring a discharge between two electrodes when high voltage is applied. This current is then a function of pressure for a given applied voltage and magnetic field. Long life and trouble-free operation is achieved through use of conservatively rated solid-state components; the cold-cathode gage tube itself is easily mounted into existing systems.

Circle No. 242 on Subscriber Service Card

Delay Generator

Developed by STL Products, the STL Model 2A trigger delay generator provides accurately controlled delayed pulses for triggering laboratory and diagnostic equipment from either an optical input or an electrical input.

A wide degree of triggering freedom is permitted by aiming the five-foot fiber optic probe at a luminous event. Only 250 microwatts on the photodiode is needed to produce a low impedance output triggering pulse adjustable from 50 to 500v.

The electrical input will accept a fast-rising pulse of 1 to 500v. The output-triggering pulse can be delayed in four decades from 0 to 99.99 microseconds with reference to the zero-delay pulse. The zero-delay pulse appears immediately after the input signal with 30 nansoconds internal delay.

Circle No. 243 on Subscriber Service Card

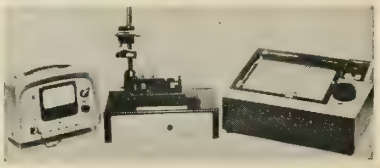
Miniature Couplers

Scanivalve Co. is marketing miniature couplers for a rapid connection to stainless steel tubing as in laboratory pressure testing. Clamping collet can be operated with thumbnail, yet operates to 2000 psi air due to an internal piston that provides added closing force. Standard units have clamping collets both ends, or male thread one end.

Circle No. 244 on Subscriber Service Card

Gage System

A precision electronic gage system that measures the linear profile and contour of individual part surfaces to millionths, and provides a permanent





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At Martin, systems management means the best possible product in the shortest possible time at the lowest possible cost.

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Essential to Nuclear Submarines

The nuclear powered submarine is one of the most complex weapons systems yet devised. To the exacting requirements of building a ship to operate safely, quietly and efficiently at high speeds in the rigorous environment of *inner space*—as foreign to man as interplanetary regions and in many aspects still as unexplored—are added the problems of nuclear propulsion plant engineering, missile systems operation, and life support conditions for *scores* of men.

It is no wonder, then, that Engineers from many disciplines work together—and in so doing, broaden their professional scope—at Electric Boat, birthplace of the nuclear powered submarine.

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Your inquiries are invited.
Please address Mr. Fred Whitehouse.

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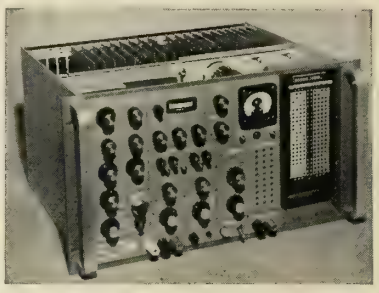
chart record of the relationship of one part surface to another, has been developed by the Cleveland Instrument Co., a subsidiary of the Bendix Corp.

The "Indi-Trace" permits accurately charting such part surface relationships as straightness, flatness, parallelism, alignment, waviness, size, taper, bellmouth, or chord radius. These relationships are obtained by repositioning the single gage head to make individual tracings of the desired surfaces.

Circle No. 245 on Subscriber Service Card

Telemetering Decommutator

Electronics Div. of The Ralph M. Parsons Co. is marketing a solid-state decommutation system featuring high



performance with small size, low weight. The Model 3DS200 consists of a group of integrated plug-in assemblies and is capable of de-multiplexing time-shared pulse-amplitude, pulse-duration, and pulse amplitude non-return-to-zero modulated information bits. Sampling rates are from 12 pps to 5000 pps, with exceptional system stability of 0.1% of full scale for 30 days.

Circle No. 246 on Subscriber Service Card

Pressure Encoder

Glassco Instrument Co. is marketing a line of digital pressure encoders based on the Bourdon-Helix principle.

The TD series provides pressure measurement in digitally coded form. The electrical output of the TD units can be transmitted directly to digital readout devices such as numerical indicators and printers, or to data-processing equipment. Applicable to gas or hydraulic pressure measurements in aircraft and missiles, the series eliminates analog-to-digital converters and offers essentially error-free data transmission.

Circle No. 247 on Subscriber Service Card

Volt-Milliammeter

Wilk Instruments has available the d-c-incremental volt-milliammeters, Models D-2 and D-3, which provide 10 ranges of voltage measurement from



If you're a Space Electronics Engineer . . .

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Why? Because Collins offers you a chance to make significant contributions to some of the most important space communication work now being done. ☐ To date, Collins has engineered the communication systems which have carried American voices from space in every flight from the X-15 to Astronaut Schirra's 6-orbit flight. Our engineers are currently readying extensive systems for NASA's Apollo manned lunar spacecraft. ☐ What's next? ☐ Further investigation into the field of space communication. Further development and refinement of the equipment and systems needed for future space flights. Further extension of Collins' leadership in the field through research, development, design and the practical application of the results in these areas to future space communication needs.

Specialists in the fields of HF, VHF and UHF equipment. Information theory, digital communications, TV, radar, and modulation techniques. Tracking and ranging. Spacecraft antennas and ground systems.

A degree in E.E., M.E., Mathematics or Physics. And since our space communication projects are in various stages of development, we need experience at all levels.



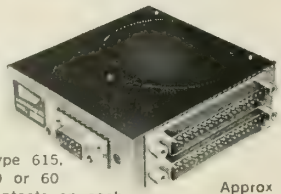
COLLINS

Write, attention
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Collins Radio Company
Cedar Rapids, Iowa

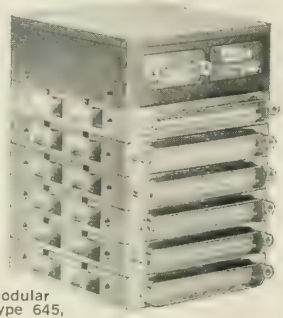
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Type 615, 30 or 60 contacts on each of 1 or 2 poles

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Modular Type 645, 1 to 6 poles, up to 60 contacts per pole

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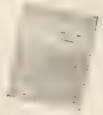
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Rotoflex precision commutators provide maximum reliability in time division multiplexing of these and many other high and low level data parameters: temperature, vibration, voltage, pressure, radiation, ionization, acceleration, ablation.

ACTON Laboratories Inc.
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Circle No. 48 on Subscriber Service Card

one to 1000v d-c. Each range is further divided into 10 subsidiary ranges. In illustration, a full scale deflection can be obtained for each 0.1v increment on the 0 to 1v range.

Used as a milliammeter the instrument provides 10 ranges from 1 milliampere to 1 ampere, and is again divided into 10 sub-ranges of full scale deflection, permitting a reading resolution of 1 μA/div on the lowest setting.

Circle No. 248 on Subscriber Service Card

Vibration Equalizer

Aero Geo Astro Corp. has developed a random motion vibration spectrum equalizer that provides all the equipment required to add a manual random-noise-vibration test capability to an existing sinusoidal vibration-test facility.

Compensation for, or equalization of, the vibration table and specimen resonance is accomplished through use of a parallel bank of 80 individually equalized magnetostriction filters. Signal level through each filter is controlled by a separate, logarithmically scaled attenuator. Each channel of the bank of 80 magnetostriction filters has a bandwidth of 25 cps. Thus, the equalizer basically covers the band from 10 to 2000 cps, inclusive. As a special feature, a switching capability has been included that permits selection of the equalization bands up to 10,000 cps.

Circle No. 249 on Subscriber Service Card

Vertical Gyro

The ARG-5 vertical gyro developed by Aeroflex Laboratories, Inc., utilizes unique capacitor-type pickoffs to sense roll and pitch and to drive the erection torquers to maintain gyro verticality. The gyro is hermetically sealed in a dry nitrogen atmosphere. The self-contained electronic oscillator-detector is mounted atop the gyro compartment to facilitate removal and servicing without breaking the gas seal.

The free drift is 15 minutes of arc per minute of time exclusive of Earth's rate, and the static accuracy is one minute of arc. A variable erection rate of 1 to 15 degrees per minute of time is provided.

Circle No. 250 on Subscriber Service Card

Radiometer

A radiometer designed for measuring the energy of laser output pulses is available from Westinghouse Electronic Tube Div. It is a calorimetric device, relatively insensitive to wave length of the incident radiation. Sensitivity of the Model RN-1 at 6943 angstroms is 625 microvolts per joule. Stability after 15 minutes warmup is

CAREER APPOINTMENTS

NASA

CONTROL ENGINEERS

for Advanced Propulsion Control Systems

NUCLEAR
NUCLEAR-ELECTRIC
HYDROGEN-OXYGEN

The NASA Lewis Research Center now offers outstanding new career opportunities to control engineers for work in two important areas involving advanced propulsion systems. The positions are in Cleveland, Ohio, and at Lewis' Plum Brook Research Station in Sandusky, Ohio.

Positions at the Lewis Center require measurement of system dynamics, analysis and selection of controls, and tests of control systems together with the propulsion systems. Propulsion systems include the NERVA nuclear rocket, hydrogen-oxygen rockets for APOLLO applications, and nuclear-electric deep space rockets.

The career opportunities at the Plum Brook Station are in a newly established automatic controls group. This group enjoys direct responsibility for design and operation of the unique control systems used in conjunction with large rocket test facilities. The control systems will help establish required operating parameters during testing of turbines, pumps, turbo-pumps, and hot firing rocket engines.

Please send your resume to: Mr. C. D. Ferraro, NASA Lewis Research Center, Dept. GN-1, Cleveland 35, Ohio.

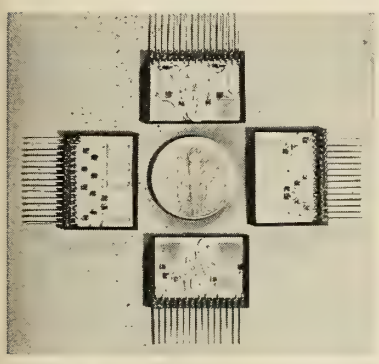
Positions filled under Aerospace Technology Announcement 252-B. NASA is an equal opportunity employer.

approximately one microvolt per five minutes. Thermal relaxation time is 20 seconds to ½ value. Useful range is 0.01 joule to 5 joules per cm^2; higher energy densities are measured using beam diverging or splitting techniques.

Circle No. 251 on Subscriber Service Card

Digital Modules

Varo, Inc. has available a series of compatible digital building block modules using thin-film microcircuitry



techniques, which perform logic functions at a rate in excess of 10 mc per second and each unit may be employed as an entity, e.g., the monostable multivibrator is capable of operation as a divide-by-two countdown at frequencies greater than 50 mc per second.

Modules operate with specific performance across an ambient temperature range of −65°C to 125°C.

Circle No. 252 on Subscriber Service Card

Tantalum Capacitors

A line of 100-v solid tantalum capacitors is being marketed by Kemet Department of Linde Co.

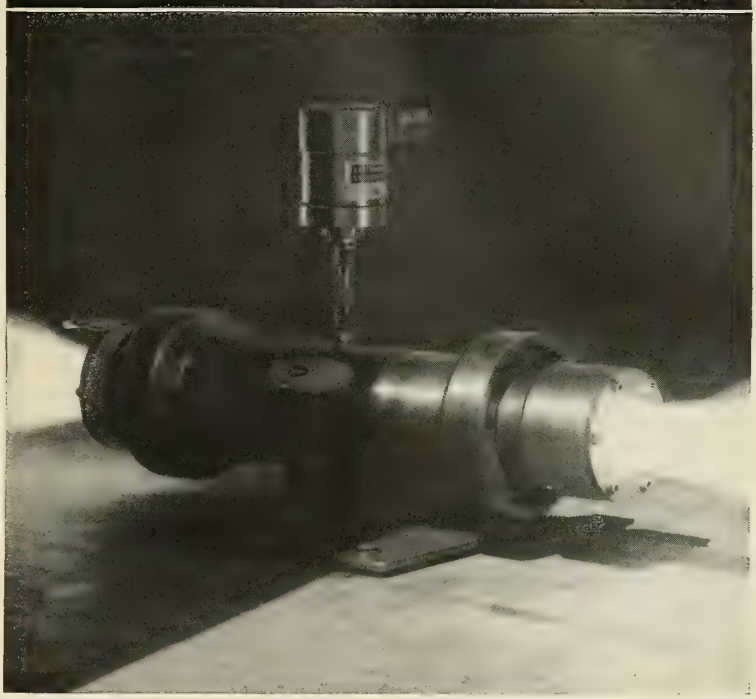
100-v units are available in corrosion-resistant metal cases, conforming with the mechanical specifications and performance requirements of Styles CS12 and CS13 in MIL-C-26655A. They exhibit the same resistance to mechanical shock and vibration, stability of electrical parameters with temperature change, and low levels of leakage current as the lower voltage J-series units. The maximum dissipation factor is 3%.

Circle No. 253 on Subscriber Service Card

Quotentiometer

Model Q20 Quotentiometer has been developed by The Data Technology, Inc., to provide a rapid measurement of the output of any strain gage transducer to exacting standards in either field or laboratory. The unit will accept transducer outputs of 0 to 1000 ohms and provide full-scale read-

Taber TELE-NEWS
about TELEDYNE® and TELEFLIGHT® pressure systems



Taber Transducer senses chamber pressure of two-headed rocket test motor for UTC

Used by United Technology Center to test new rocket nozzles, a Taber TELEDYNE® Strain Gage Pressure Transducer measures high temperature combustion chamber pressure in a unique rocket motor. Named after the Roman god, Janus, because it fires simultaneously from both ends, the motor permits testing of two types of nozzles under identical conditions of internal pressure and ballistics. With a single firing, UTC scientists can determine any differences in ablation rates between tubular and conventional nozzles.

Featuring an extremely small pressure cavity for fast reponse, Taber Bonded Strain Gage Pressure Transducers are ideally suited to a wide range of test and operational applications. Compact and rugged, they provide: high frequency response, infinite resolution, hysteresis of less than 0.25% full scale, and low sensitivity to temperature effects, shock or vibration.

For detailed information on Taber Transducers (in pressure ranges from 0-25 thru 0-10,000 psi), mail this coupon attached to your letterhead.

TO: TABER INSTRUMENT CORPORATION
AEROSPACE ELECTRONICS DIVISION SECTION 217
107 Goundry Street, North Tonawanda, N. Y.



Send detailed information on Taber Teledyne® and Teleflight® bonded strain gage pressure transducers.

name _____ title _____

company _____ dept. _____

address _____

city _____ zone _____ state _____

Circle No. 49 on Subscriber Service Card

out of 10 mv/v with a resolution of five parts per 1,000,000 of full scale.

This device measures the ratio of input voltage to output voltage of the transducer under test, and therefore is independent of transducer excitation voltage.

Circle No. 254 on Subscriber Service Card

Electromagnetic Pump

An electromagnetic pump that will handle alkali metals at temperatures up to 2000°F has been developed by Atomics International.

The helical rotor electromagnetic pump can be designed to pump such metals as sodium, NaK, potassium and cesium at capacities from near-zero to 50,000 gpm. The flow rate can be varied over a wide range by changing the direct current supplied to the rotor windings.

Using liquid sodium, the pump has attained an efficiency of 26% at 2200 gpm, developing 34.5 psi. The maximum flow rate was 2750 gpm; maximum developed pressure was 45 psi.

Circle No. 255 on Subscriber Service Card

Miniature Vertical Sensors

Vertical sensing elements built of glass are being marketed by Kearfott Div., General Precision Aerospace, to be used in applications such as sounding rockets, target drones or camera stabilization systems.

One of the vertical sensing elements, the C70 1808 000, measures only ¾-in. length and weighs 5 gr., yet is a single axis, low cross-coupling-error damped vertical sensing element that provides an a-c output signal which increases proportionately with tilt about a sensitive axis in either direction from level to ±1°. This unit may be employed either as a vertical reference for vertical gyros and inertial platforms, or as a very accurate level sensor having a repeatability of ±3 arc seconds.

Circle No. 256 on Subscriber Service Card

Heatmeter

An instrument for accurate measurement of heat flow in the fields of satellite and rocket systems, thermal insulation and control has been developed by Geonetics Corp. The unit includes a transducer, a detachable transducer handle and an indicating meter with appropriate range change and polarity reversing switches.

The device indicates heat flow from, to, or through most surfaces over the normally encountered range of 1 to 500 BTU/hr. sq. ft. A patented process allows a large number of thermocouples to be connected in series in a small area, making it possible to detect very small temperature differences.

Circle No. 257 on Subscriber Service Card

Switching Transistors

Bendix Semiconductor Div. has available a series of three 25-amp high-speed switching transistors designated 2N2636-2N2638. The transistors are capable of safety switching clamped inductive loads in microseconds at peak powers of 1000, 1500, and 2000 watts, respectively.

The 2N2636, 2N2637, 2N2638 series can switch 25 amps at collector-emitter voltages of 40, 60 and 80v, respectively without destructive breakdown when the collector current fall time is kept under 30 microseconds. Typical switching times range from 1 to 5 microseconds.

Circle No. 258 on Subscriber Service Card

Frequency Changer

NJE Corp. has available two versions of a solid-state frequency changer. The Model TFC-115-100 frequency changer has variable output voltage and frequency of 105 to 130v a-c and 380 to 420 cps, respectively. The Model TFC-26-100 changes the output voltage to 24 to 30v.

The static voltage regulation is ±1%

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Home of Brevard Engineering College

Circle No. 50 on Subscriber Service Card

and the static frequency regulation is ±½%. The recovery time is 30 milliseconds or less for a zero to full load step, and 10 milliseconds for a full load to a zero step. The output voltage remains within 2% of the output setting, with input line changes of ±10% of nominal.

Circle No. 259 on Subscriber Service Card

Motor Load Controller

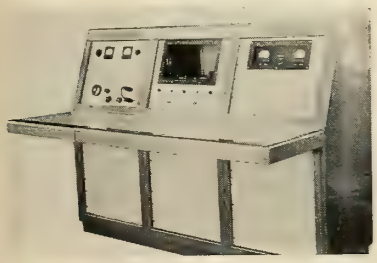
Seneca Falls Machine Co. has developed a motor load controller that continuously monitors the electric power flowing into an a-c induction motor. Line voltage, line current and power factor are sensed simultaneously to provide a true indication of torque. It can be used on any machine or equipment driven by an a-c induction motor operating on 110, 220, or 440v, single or three phase. It detects dull or broken tools, prevents product damage, signals machine or process malfunction, and avoids motor burnout.

Typical applications are limiting manual feed rates, sensing loss of load, detecting conveyor jam-ups, indicating end of process and applying corrective action during a process.

Circle No. 260 on Subscriber Service Card

Ultrasonic Generator

The broadband ultrasonic generator is available from International Ultrasonics, Inc. with power output as high as 5 kw. The company has developed 1 kw and 5 kw models in addition to its original 250-watt generator. All models are continuously tunable through an output frequency range from 10 kc, or lower to 2 mc, at any power level from zero to full rated output. This frequency



range enables a research or process development laboratory to obtain output at any frequency it might require for any ultrasonic investigation, from a single generator. Output impedance is 92 ohms.

Circle No. 261 on Subscriber Service Card

High-Voltage Power Units

A series of unitized high-voltage power supplies featuring full floating output with 7.5 kv insulation to ground

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OF SCIENTIFIC AND ENGINEERING COMPUTERS

Know the facts—and you will know the one sure way to find the computer that suits you best

The fastest computer is the most efficient.

TRUE ( ) FALSE ( )

False, if by "fastest" is meant computing time only. Usually it represents only about 10% of the total time required to solve a problem. Base your judgment on "total problem-solving time," remembering that programming is often 90% of the job. The Recomp® line of small and medium-scale computers is designed to save, not microseconds in computing, but hours in problem solving. They are simple to program, easy to operate, have exceptionally large memories.

Comparably priced computers are about alike.

TRUE ( ) FALSE ( )

False. Computers vary rather widely in efficiency, and vary in ways they can be used. And true cost isn't always reflected in the price tag. Make sure, when you buy, you are getting the entire working system your job requires. For example, the Recomp III, a complete engineering computer system, is ready to start solving problems when you plug it in. It leases for just $1,495 and is an ideal small-scale computer. For medium-scale needs, Recomp II can be leased starting at $2,495.

Computer operation requires special personnel.

TRUE ( ) FALSE ( )

True or false, depending on your computer choice. Some do—a factor to consider in connection with cost. But here is another important consideration. Computers which require programming personnel for operation double the communication time between the originating scientist or engineer and the computer. Direct contact between the computer and the user increases efficiency and reduces chance for error. Engineers with less than eight hours instruction have been able to use Recomp computers profitably.

There is no simple way to judge a computer.

TRUE ( ) FALSE ( )

True. However, a feasibility study aimed at determining which computer best suits your company's needs can help you make a sound choice with a minimum of wasted effort. Incidentally, no feasibility study is complete without consideration of the Recomp line of solid-state computers. Would you like to learn the "shortcuts" of studying computer values? We will be happy to send you a free copy of the interesting "Management Guide to a Computer Feasibility Study." Use the handy coupon below.

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is available from Alfred Electronics. Five models provide voltage ranges of 0 to 5000 volts at current capacities up to 150 ma. Ranges available are 0 to 500 volts at 0 to 100 ma, 0 to 1500 volts, 3500 volts and 5000 volts at both 0 to 50 ma and 0 to 150 ma ratings.

Each supply has adjustable overcurrent trip-out and current range switching to protect devices under test. Trip-out can be set as low as 0.3 ma on 50 ma supplies, and as low as 0.5 ma on 150 ma units, allowing safe use in low-current applications.

Circle No. 262 on Subscriber Service Card

Conversion Rule

Developed by Scope Aid, a pocket-sized, circular converter rule helps the oscilloscope user to read all recurring waveforms (symmetrical, non-symmetrical, pulse, time mark signal, etc.) in direct frequencies without calculation. It can be used on any standard time/div. range of any 10-division graticule oscilloscope. It is 5-in. in dia.

Circle No. 263 on Subscriber Service Card

Scanner Relay

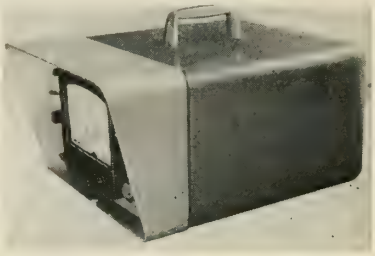
Available from Farmer Electric Products Co. is a pulse-stretching circuit that enables the magnetic system to respond positively to impedance-changes of shorter duration than the response time of its electromagnetic relay. The device permits the Farmer Type PE-4 scanner-relay to provide reliable operation at counting rates up to 2400 per minute.

A light-beam interruption or a light impulse as short as 0.0005 sec. activates the relay, whose hold-in time can be adjusted from 0.02 to 0.10 sec. or (with an auxiliary capacitor) up to 2.5 sec.

Circle No. 264 on Subscriber Service Card

Ratio Pyrometer

Infra Red Eye, operating in the infrared sector of the spectrum, brings the science of two-color pyrometry to



temperature ranges between 500°F and 1500°F. It is available from Milletron, Inc., and measures continuously, automatically and accurately over its full range with emissivities as low as 0.01. The unit features an internal, automatic calibrator that continuously checks and standardizes the instrument and gives it lifetime stability without regard to component aging or voltage variations. It is accurate over its full range and indicates by means of a direct-reading linear 6-in. meter, which may be part of the sensing apparatus or may be remotely mounted.

Circle No. 265 on Subscriber Service Card

Bandpass Filters

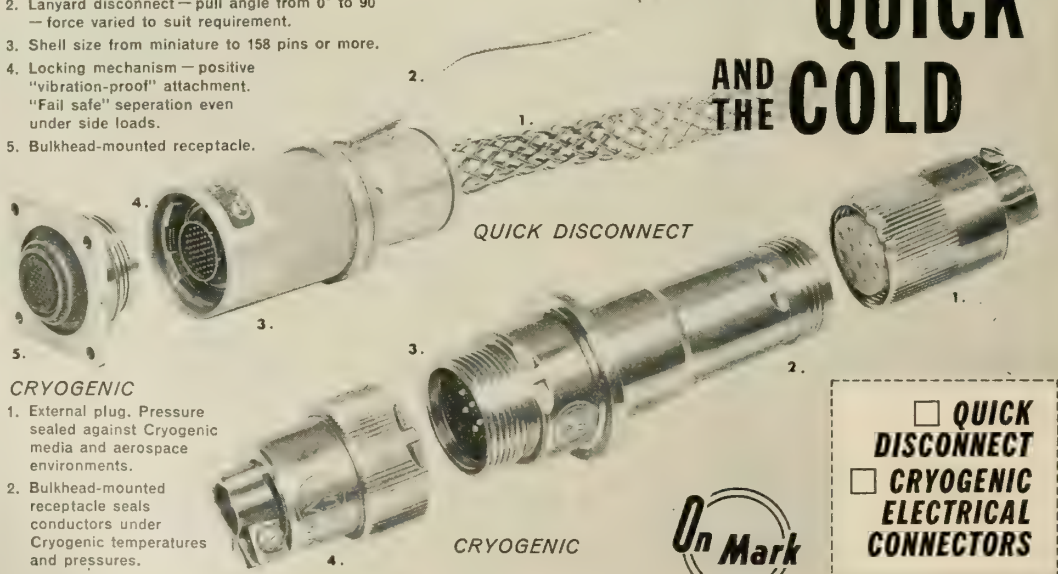
Magnetically tunable microwave bandpass filters utilizing single crystal yttrium iron garnets have been developed by Instrument Systems Corp.

The new single-stage, narrow-bandwidth YIG devices—with 2-4-kmc frequency range and 0-1-kc tuning rate capability—are in three models, 3016-G, 3016-M and 3016-E.

All-electronic Model 3016-E has no moving parts; rapid sweep rates suit it to countermeasures and analyzer-type apparatus; a generator can be installed to monitor the magnetic field for direct frequency measurement and for providing feedback information. Model 3016-G, with no sliding contacts, is used for the front end of

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QUICK DISCONNECT
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radar, beacon and communications equipment, for purposes of image rejection, frequency analysis and signal separation. Model 3016-M is a dial-calibrated, manually operated unit for general laboratory usage and receiver-type equipment.

Circle No. 266 on Subscriber Service Card

Dataplotter

A digital plotter designed for scientific, industrial and military uses—where fast, graphic recording of digital coordinate data is needed—has been developed by Electronic Associates, Inc.

The 3500 Dataplotter operates on-line as well as from card or paper tape readers and is capable of plotting points, symbols, or lines at speeds as high as 200 points or 120 lines a minute, a tenfold increase in plotting speeds compared with other plotting systems. Accuracy for point plotting is ±0.05% of full board width; repeatability is within ±0.01%, and line plotting is within 0.015-in. of straight-line interpolation with 0.05% of full board width for the end points. The system accepts information in the form of four decimal digits plus sign in both x and y.

Circle No. 267 on Subscriber Service Card

Multiplex System

Electronic Communications, Inc., has developed a multiplex system for exacting airborne requirements.

The system, which meets MIL-E-5400 specifications, will operate at altitudes up to 50,000 ft. in a temperature range of −55° to 71°C with no external cooling required. It will withstand up to 15-g shock and vibration up to 500 cps at 15 g's.

The basic 12-channel system is contained in four boxes and packaged to meet MIL-C172C specifications.

Circle No. 268 on Subscriber Service Card

Solid-State Relays

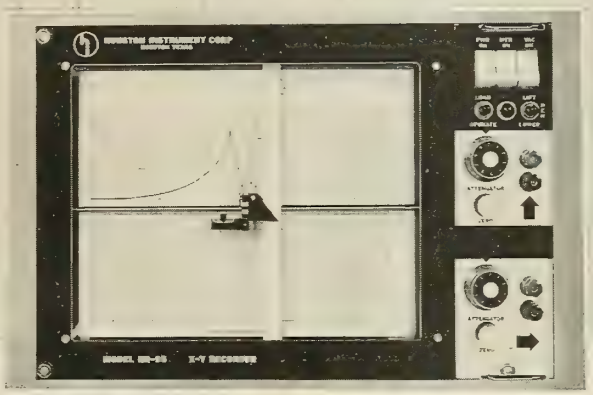
Aeromarine Electronics, Inc., is marketing a line of solid-state power relays for use as direct replacements for electromechanical devices. The relays will operate from dry contacts or a wide range of a-c or d-c input signals. Complete isolation between activation source and switching contacts is provided.

Circle No. 269 on Subscriber Service Card

Solar-Blind Phototube

A rugged solar-blind multiplier phototube is being marketed by the Princetown Div. of Electro-Mechanical Research, Inc., for study and measurement of the far ultraviolet region of the spectrum. Model 542G-08 features

8½" x 11" X-Y RECORDER



Model HR95-T0

$1250

Performance: 1 mv/in. basic sensitivity, 15 in/sec. pen speed, 0.25% overall accuracy, 600 in/sec² peak acceleration, 0.1% resetability.

Reliability: Special emphasis on a simple, straightforward design insures continued trouble-free performance. The HR-95 is fully warranted for one year.

Flexility: Plug-in control modules and compatibility with all standard converters and accessories, including the complete Houston Instrument line, assure the capability of the HR-95 to perform all recording functions.

Accessibility: Modular construction plus hinged recording surface permits complete access to all electrical and mechanical components in seconds.



Price: $1250 No time base
$1350 With time base

8 page brochure available upon request

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Circle No. 52 on Subscriber Service Card

peak sensitivity between 1250 and 1450 angstroms, with solar-blind characteristics beyond 2100 angstroms, assuring the tube's insensitivity to the visible portion of the spectrum. The combination of a lithium-fluoride window with a semitransparent photocathode provides a quantum efficiency of approximately 10% at 1216 angstroms, while the thermionic emission from this cathode is of the order of only a few electrons per sec. per sq. cm. Designed for high-gain operation, the tube employs 18 stages for stable current amplification.

Circle No. 270 on Subscriber Service Card

Self-Lubricating Materials

Self-lubricating materials—that can carry loads as high as 1800 psi with little self wear and negligible wear of the surfaced against which they are sliding—are available from the Westinghouse Material Mfg. Div.

The materials are homogenous silver- or copper-based composites containing small amounts of a "film former" called polytetrafluorethylene and a novel dry lubricant called tungsten diselenide.

The tungsten diselenide is held in small pockets throughout a metal base. When the base rubs against another metal surface, the tungsten diselenide forms a dry lubricating film that transfers back and forth from one surface to the other—thus healing any tiny break or fault that may occur—so that adequate lubrication is provided.

Circle No. 271 on Subscriber Service Card

Medium Power Supplies

Alpha Scientific Labs is marketing medium-range power supplies providing either voltage or current regulation to an accuracy of one part in 100,000 over a wide range of currents and voltages. There are two standard ranges, 0-45 volts and 0-100 volts, with maximum current capacities of 5 amps, 10 amps, 20 amps, and 50 amps in each type. Operation from 11v or 200v single-phase, or 220v three-phase, 50-60-cycle power lines is available.

The power supplies are completely solid state and are available with 1 part in 10^3, 10^4, or 10^5 regulation.

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scale, or as currents of ±1ma full scale. Operational amplifiers, sample and hold amplifiers, DAC switches, multiplexer switches, comparators and axis-crossing detectors all are designed as high-speed, precision devices, and settle to within 0.01% of final value in less than 10 microseconds. Basic analog sensitivity is on the order of 50 to 100 microvolts and 10^{-7} amps.

Circle No. 273 on Subscriber Service Card

Prism Laser Q Spoiler

A 1500-rps rotating prism laser Q spoiler than can produce pulse durations as short as 50 nanoseconds with peak output power in the megawatt range is being marketed by Beckman & Whitley, Inc.

Model 402 is designed to Q-spoil laser beams up to ⅝-in. dia. To obtain shortest possible shuttering time and also to eliminate critical alignment problems, a total internal reflection prism is rotated on an axis parallel to the prism hypotenuse and perpendicular to the roof edge.

The prism is rotated by a compact turbine, which will operate from either a small compressed-air supply, or from nitrogen. So that the laser can be pumped in synchronization with the prism position, a built-in pickup coil, rotable through 360°, generates a sine wave proportional to the rotational speed of the prism. The signal can also be used to monitor prism speed.

Circle No. 274 on Subscriber Service Card

Monochromatic Light

Available from Crane Packing Co. the Lapmaster monochromatic light measures surface flatness to within 0.000001-in. or 0.000002-in. on lapped parts up to six in. in dia.

Using a helium lamp of known wavelength, the unit casts a strong glare-free light that produces readily observable light and dark bands on most reflective or semi-reflective surfaces. With Lapmaster optical flats of certified accuracies, the light allows flatness readings to millionths tolerances. The transformer is U.L. approved and operates on standard 110v, 60-cycle current.

Circle No. 275 on Subscriber Service Card

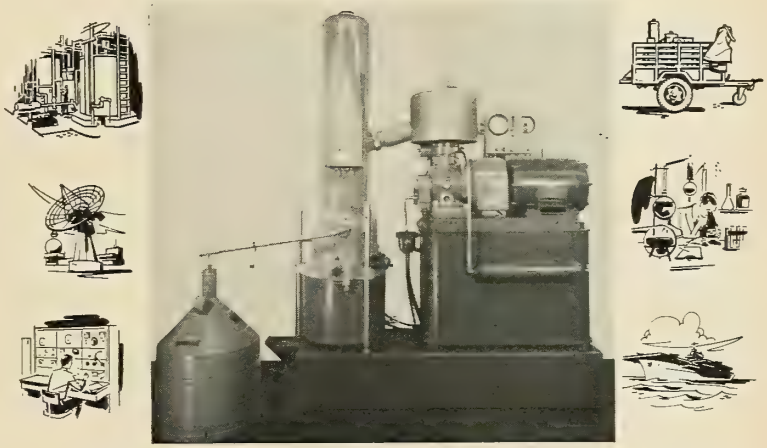
Gas Chromatograph

A completely versatile analytical research instrument, the Model 810 dual column flame ionization gas chromatograph developed by F&M Scientific Corp. features stable high-temperature dual column operation, fully automatic temperature programming and multiple detection systems.

The Model 810 features isothermal or automatic-temperature-programmed



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Norelco Liquid Nitrogen (LN_2) Generators provide economical and compact systems for the *instant production* of LN_2. The rugged Model A generator, shown in photo, produces 6.5 to 7.0 liters of LN_2 per hour as a *laboratory-pure* product. Norelco "package plants" are delivered ready for *immediate installation* and on-site production of LN_2.

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CAPABILITY

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MISTRAM Analog Computer Subsystem. Data Multiplex, Timing Subsystem.

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DISCOVERER Acquisition and Position Control of Tracking Antennas. Transmission of Real Time Target and Acquisition For Orbit Insertion.

MARS Time Code Generators and Timing Distribution System.

RANGER Real Time Data Handling System for AMR Tracking Sites.

NASA Wallops Island Test Station, Analog/Digital Data System.

GLOTRAC Inter-site TTY Transmission, Digital to Synchro Conversion Subsystems.

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operation from ambient to 500°C. In addition, both the detector and injection port temperatures are also separately adjustable from ambient to 500° C, allowing all the important system parameters to be set independently for optimum performance. The low mass column oven design, in conjunction with precise power proportioning temperature control, provides rapid heating and cooling characteristics.

Circle No. 276 on Subscriber Service Card

Transistor, Diode Tester

A portable instrument that balances effects of circuit impedances to accurately measure parameters of semiconductor devices installed in circuits has been developed by Test Equipment Corp. The unit measures the true small-



signal a-c current gain at a frequency of 1 kc. the a-c beta range is 3 to 1000. The d-c operating current is continuously variable to 1000 ma. This unit also performs in-circuit measurements of the saturation voltage of transistors and forward voltage drop of diodes and rectifiers.

Circle No. 277 on Subscriber Service Card

Spectrum Analyzer

Marketed by Spectran Electronics. the Model 40-15WS spectrum analyzer displays real time transient analysis on a 5-in. cathode ray tube. The analyzer employs an array of 40 narrow-band filters placed in a contiguous arrangement throughout a 500-cycle analysis band. By adjustment of a local heterodyning oscillator, the analysis band can cover signals between 30 cps and 20 kcps. The filter array is sampled 45 times per second, giving a substantially instantaneous and flickerless display on the CRT.

Circle No. 278 on Subscriber Service Card

Atom Measuring Device

A device that can measure a distance as small as the "gap" between two atoms—one thousandth of a mil-

Circle No. 55 on Subscriber Service Card

lionth of an inch—has been developed by North American Aviation, Inc.

The measurement, using a helium-gas neon laser, was completed with a specially adapted interferometer to demonstrate that measurements can be made to detect motion to an accuracy of 1/24,000 of a wavelength of light.

Circle No. 279 on Subscriber Service Card

Delay Line

Available from Computer Devices Corp., the DA412 audio frequency delay line provides long delay with a high degree of phase linearity over a wide frequency range. Delay is five millisec. with 125 tap points spaced evenly every 40 microsec., and tap accuracy better than ±1%. Phase linearity over a frequency range of 100 cycles to 2.5 kc is within ±¼% up to 3.5 kcs. Insertion loss is less than 2 db and attenuation is ±0.5 db from 100 to 2500 cps; 3 db maximum at 3.5 kcs and cut-off is at 5 kcs. Impedance is 1000 ohms ±10%.

Circle No. 280 on Subscriber Service Card

Deviation Bridge

The Digitohm, a digital resistance deviation bridge, is available from Solartron, Inc., a subsidiary of Electro-Mechanical Research, Inc.

The Model EM 1291.2A is a self-balancing precision bridge that measures the percent deviation of resistors from rated value; and it displays deviation directly as a percentage in a five-window in-line digital readout.

The Digitohm combines a broad testing range of 10 ohms to 15.9 megohms with 0.1% accuracy. Controls permit the nominal resistance value and allowable deviation limits to be set into the Digitohm. Deviation limits from ±0.1% to ±9.9% in 1% steps are available.

Circle No. 281 on Subscriber Service Card

Thermo-Servo

Thermotron Corp. is marketing the F-2 Thermo-Servo, a pure-freon cascade-cooled unit, developed as a self-contained temperature test chamber, 350°F to −100°F. As a combined environmental test chamber, the unit will condition a temperature hood from 300°F to −68°F. Insulated Thermo-Flex duct connects the conditioning chamber to a one cubic foot hood. The hood can be mated to most any size vibration exciter for conditioning accelerometers or other temperature-vibration devices.

Circle No. 282 on Subscriber Service Card

Solar Cells

Ion Physics Corp., aerospace subsidiary of High Voltage Engineering Corp., has developed electricity using

WHO PUT POLARIS IN THE CLASSROOM ?

Polaris is in the classroom—a special classroom with built-in launch tube—in the Polaris Training Building at the U.S. Naval Guided missile school at Dam Neck, Virginia. It is here that Navy personnel are trained to handle this powerful member of our country's missile arsenal.

Standing 50 feet above the Training Building roofline is a giant, 30-ton bridge crane designed and manufactured for the Navy by Washington Technological Associates, Inc. of Rockville, Maryland—an equipment as unique, in many ways, as the Polaris itself.

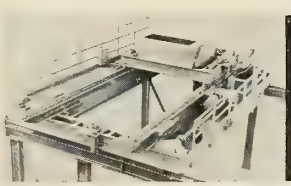
The first of its kind, the crane—operating from remote, push-button controls—lifts the 31-foot-long missile a soaring 86 feet into the air, positions it accurately within fractions of an inch and lowers it gently into the launch tube.

All these precision operations, fully-controlled by the operator, are safeguarded and insured by the built-in automatic interlocks and indexing devices. And . . . the entire dual-rail traveling crane and trolley was designed and produced by WTA in less than one-third of the original time schedule.

In a very real sense, WTA has helped the Navy put Polaris in the classroom.

The 30-ton bridge crane is only the latest example of WTA's comprehensive ability—recognized for more than a decade—to solve tough missile handling and engineering assignments. At WTA, today's challenge is tomorrow's achievement!

Our engineers will be glad to consult with you. Your inquiry is invited.



WTA

Washington Technological Associates, Inc.

979 ROLLINS AVENUE • ROCKVILLE, MARYLAND

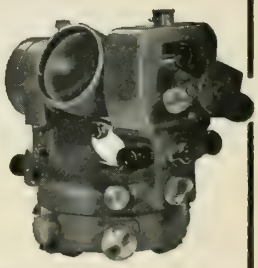
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U.S. AIR FORCE AND NAVY APPROVED FACILITIES
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solar cells made with its ion implantation process. IPC's solar cells converted light into sufficient electricity to operate an electric fan. This technique utilizes a beam of boron ions accelerated by a High Voltage Engineering Van de Graaff accelerator to produce a precisely-controlled PN junction in a semiconductor material, thus making it capable of converting light directly into electricity. Such solar cells will be considered for use in satellites and other spacecraft.

A feature of ion implantation is the ability to program and closely control the degree of change in semiconductor conductivity by varying the energy and current of the ion beam, or the duration of irradiation.

Circle No. 283 on Subscriber Service Card

Meteorite Puncture Detector

A system to detect and locate meteorite punctures on manned space vehicles has been developed by the Martin Co.'s Denver Div.

The system would fill the space between the bumper and the pressurized hull with vinyl bags about five feet square. Insulating materials could be enclosed within the bags.

Each bag would be punctured before being packed into the space between the bumper and cabin to permit expanding gases to escape as the spacecraft leaves Earth's atmosphere. Punctures would be necessary since gases expand as external pressure is reduced.

Pressure-sensitive transducers, or sensors installed in each bag, would react if any air pressure were introduced into the bag once the spacecraft was out of earth's atmosphere, since there would be no external pressure.

Circle No. 284 on Subscriber Service Card

Digital Simulator

Developed by Telemetric, Inc. the Model 504 digital signal simulator produces a completely programmable, coded output to meet practically all calibration and checkout requirements for PCM telemetry ground stations, data-transmission links, data-acquisition systems, and data-processing and reduction equipment. Circuitry is all-solid-state, in plug-in modular form.

Selectable coding may be binary, binary coded decimal, excess 3, biquinary, hexidecimal, or any other digital code, programmed quickly at controls all conveniently located on the front panel.

The bit rate of the output serial code is derived from an internal oscillator or an external source. With internal oscillator, the bit rate is continuously adjustable from 10 to 80,000 bits/sec.

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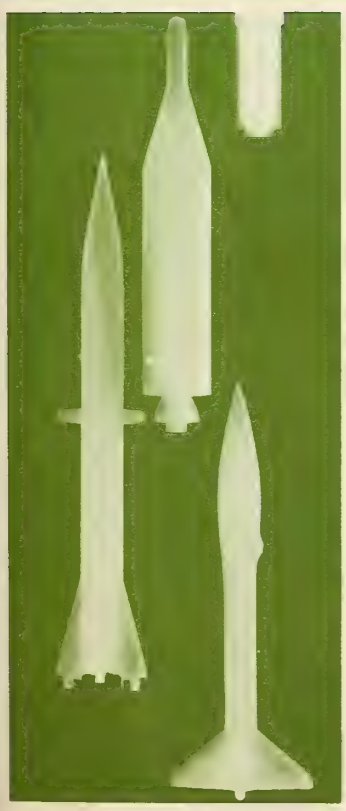
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Miniature Magnetrons

Two miniature, X-band pulse magnetrons, weighing less than 16 oz. have been developed by the Electron Tube Div. of Litton Industries.

The L-3812 is a one-kw pulse magnetron operating at a fixed frequency of 9300 mc. Operating at the same frequency is the L-3813, which provides a minimum power output of 500 watts.

Both magnetrons are all metal and ceramic, with built-in permanent bowl magnets compactly packaged in a two-inch cube that mates with the standard waveguide flange. Conduction cooled, these tubes are operational at ambient temperatures up to 150°C. Litton cube miniature magnetrons feature 13-second warm-up and short-, conventional- or long-pulse operation at 0.02 to 2.0 microseconds.

Circle No. 286 on Subscriber Service Card

Vibration Testing System

Developed by Gulton Industries, Inc., a low-frequency vibration analysis system is capable of automatically monitoring structural response to very-low-frequency vibrations at very low g levels at 100 points on the airframe.

The system generates data with an accuracy of approximately 0.1% for presentation on xy plotters and recording oscillographs. All the data, including structural location and run number, are placed on IBM punched cards for computer analysis. Internal control assures maximum operating speed regardless of number of channels or frequency of excitation, and is used at frequencies as low as one cycle per second, and g level as low as 0.005.

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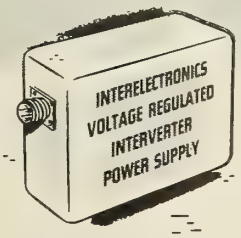
Crystal Oscillator

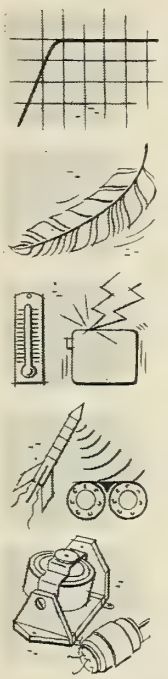
Manson Laboratories, a subsidiary of the Hallicrafters Co., is marketing a 100-kc transistorized oscillator with a frequency stability of one part in 10^7/day which is virtually free of switching transients.

The unit is for application as a frequency reference in time code generating and cryptographic equipment, and achieves its quiet switching by means of a mercury thermostat oven switch as opposed to bi-metallic sensors that create large transients. The FFO-148 is conservatively estimated to have a mean time between failure of 75,000 hrs., withstanding up to 100 g's shock and tolerating unusual conditions of vibration. Input requirements 24v d-c ±10% at 1.8 watts maximum. The unit delivers a 2-volt positive pulse into 1000 ohms.

Circle No. 289 on Subscriber Service Card

PROVEN RELIABILITY—
SOLID-STATE POWER INVERTERS
over 260,000 logged hours— voltage-regulated, frequency-controlled, for missile, telemeter, ground-support, 135°C all-silicon units available now—





Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. Wide input range (18 to 32 volts DC), high conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry).

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards).

Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

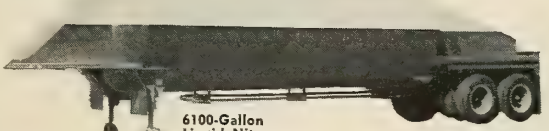
Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call LUdlow 4-6200 in New York.

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BIG PAY-LOAD IN CRYOGENICS



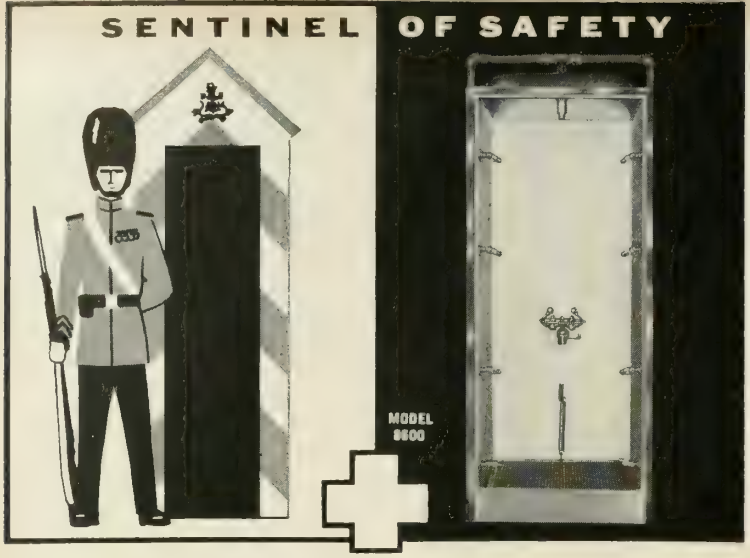
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new literature

CENTRALAB CATALOG—Centralab, Electronics Div. of Globe-Union Co., has published a 44-page catalog of its variable resistors, switches and ceramic capacitors available from industrial distributors. The Catalog 32 is designed for engineering and purchasing department use. Detailed dimensional drawings and complete electrical, mechanical and environmental specifications are given for almost all of the products described.

Circle No. 200 on Subscriber Service Card

TAPE READERS—Omnitronics, Inc., subsidiary of Borg-Warner Corp., has published Technical Bulletin PTR-80/81 describing and giving complete specifications on a series of low-cost Omni-Data Photoelectric Paper-Tape Readers, Models PTR-80 (unidirectional) and PTR-81 (bidirectional). Features of the readers include synchronous reading speeds up to 200 characters per sec.

Circle No. 201 on Subscriber Service Card

DATA REDUCTION SYSTEM—The Gerber Data Reduction System Model GARDS-4 is described in a folder published by the Gerber Scientific Instrument Co. Consisting of a reading head, control console and choice of outputs, Gerber's system will quickly scale, digitize and tabulate information from strip charts and films with resolutions up to 1000 counts per inch, the firm says.

Circle No. 202 on Subscriber Service Card

SOLID-STATE POWER SUPPLIES—A series of low-power-output subminiature solid-state d-c to d-c power converters—with wide application in airborne telemetry systems and in major missile, radar, beacon and other electronics equipment—is described by Advanced Electronics Corp. in its Catalog Bulletin No. 209PS.

Circle No. 203 on Subscriber Service Card

SILICONES—A general reference classifying all commercially available silicone materials by product and application has been published by Dow Corning Corp. The guide describes briefly the many physical forms and applications of silicones now available —including fluids, lubricants, resins, adhesives, dielectrics and water repellents.

Circle No. 204 on Subscriber Service Card

ELECTRONIC HARDWARE—The 1963 edition of a 32-page catalog illustrating Microdot's "Lerco" line of electronic hardware is available from the manufacturer. Featured are outline drawings and dimensions of standard terminals, insulated terminals, terminal boards, handles and hardware.

Circle No. 205 on Subscriber Service Card

names in the news

William E. Purdy: Promoted to vice president and general manager of DeMornay-Bonardi Corp., Pasadena, Calif.

Dr. Herbert Bandes: Appointed director of research for Eitel-McCullough, Inc., San Carlos, Calif.

Richard J. Jacobi: Joined White Electromagnetics, Inc., as head of the Electromagnetic Warfare Section, Bethesda, Md.

Robert O. Elliston: Appointed senior engineer for Stevens-Evans, Inc., San Diego, Calif.

James J. Carlin: Appointed director of purchasing of Filters, Inc., East Northport, L. I., N. Y.

Harlan W. Snyder: Elected treasurer and controller of Canoga Electronics Corp., Van Nuys, Calif.

J. Robert Esher: Appointed manager of the aerospace ground equipment department of the Martin Co., Electronic Systems and Products Div., Baltimore, Md.

L. Wayne Mullane: Appointed vice president-operations at Aerojet-General Corp., Azusa, Calif.

Dr. William M. Duke: Elected a vice president and appointed group executive-U. S. Defense for International Telephone and Telegraph Corp., New York City. **George A. Banino** elected president of ITT Federal Laboratories.

James R. Youngblood: Appointed products manager for the Industrial Div.'s data-handling equipment, Cubic Corp., San Diego, Calif.

Dr. Athelstan F. Spilhaus: Dean of the Institute of Technology, University of Minnesota, elected a member of the board of trustees of Aerospace Corp., Los Angeles.

Harold Thompson: Appointed manager of the Wollensak Optical Div. of the Revere Camera Co., Rochester, N. Y.

Dr. C. D. Pierson, Jr.: Appointed technical director, reliability and maintainability, for the Martin Co.'s Orlando, Fla., division.

Lt. Col. August F. Siemon (USAF ret.): Joined the Development Div. of International Electric Corp., Paramus, N. J.

Joseph A. Neary: Named assistant to the senior vice president-marketing at Page Communications Engineers, Inc., Washington, D. C.

William P. Bell: Appointed manager-defense products in the Washington, D. C. office of Allis-Chalmers.

John A. Swint: Appointed vice president-manufacturing at Menasco Manufacturing Co., Burbank, Calif.

Hugh E. Riordan: Appointed director of gyrodynamics research at General Precision's Kearfott Div., Little Falls, N. J.

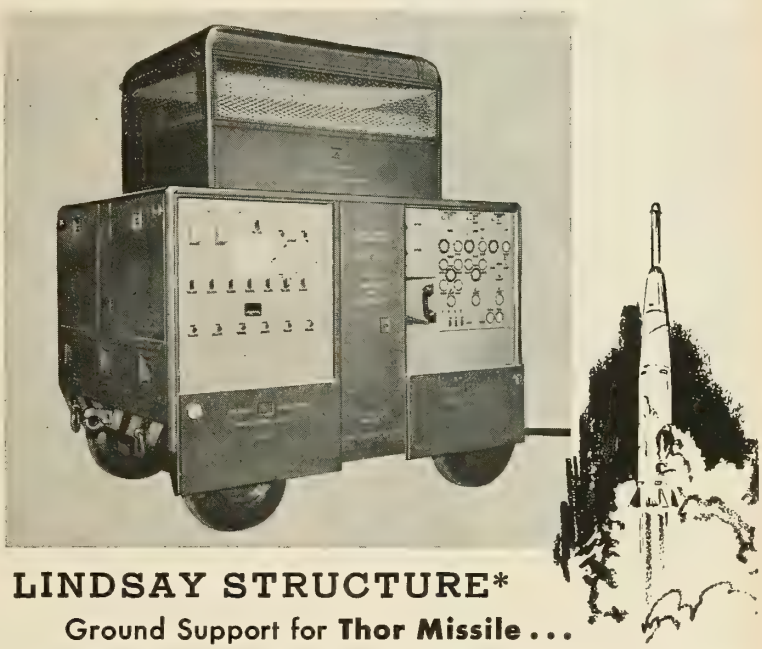
Edward J. Behney: Appointed manager of manufacturing at General Dynamics/Electric Boat, Groton, Conn. **William E. Wise** named manager of management engineering, and **Oscar R. Goode** named quality control manager.

Lawrence T. Williams: Appointed manager of the industrial relations office at Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

Charles W. Newhall, Jr.: Elected vice president of the Marquardt Corp., Van Nuys, Calif.

Lt. Col. Thomas W. Ellington (USAF ret.): Appointed West Coast public relations director for the Martin Co.'s Los Angeles office.

Dr. Donald Drukey: Appointed assistant manager of the Development Div. of System Development Corp., Santa Monica, Calif., and director of SDC's Command Research Project.



LINDSAY STRUCTURE*

Ground Support for Thor Missile . . .

- MIL Spec E-4970 for vibration, shock and environmental tests is no problem when using Lindsay Structure.
- Complies with material and finish specs MIL-E-4072, MIL-S-7720 and QQ-A-325.
- PLUS, requirements of MIL-E-4957-A are met or surpassed in rf shielded enclosures using Lindsay Structure in their manufacture.†
- Exceptional strength with light weight.
- Simplicity of assembly with no cutting, no welding, no drilling or punching.
- Unlimited combination of prefabricated panels in *any* workable metal provides freedom of design.

†Sold through Ace Engineering and Machine Co., Huntingdon Valley, Pa. See them at Booth 3928 IEEE Show, New York.

*Prefabricated metal panels and components to produce cabinets or enclosures for equipment: electronics, radar, guidance; microwave buildings; and for environmental rooms.

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The illustrated mobile air conditioner was built by C. G. Hokanson Company, Inc., Los Angeles, Calif., for the Douglas Aircraft Company. It is used at all Thor Missile launching sites.

LINDSAY STRUCTURE enclosures are now in use on Thor, Titan, Snark, Polaris, and other missile programs.

INTERNATIONAL STEEL COMPANY
Lindsay Structure Division
1443 Edgar Street • Evansville 7, Indiana

Please send information on the economical use of Lindsay Structure for ground support equipment.

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Crystallizing Ideas into Products



The white geometrical figures on this Tiros weather satellite indicate ROKIDE ceramic panels, covering areas not occupied by solar cells. As a result of development shared by the Astro-Electronics Division of RCA, prime contractors for the National Space Administration, and by Norton Company, sintered ROKIDE A aluminum oxide panels are used to maintain the thermal balance required in Tiros to assure optimum functioning of instruments.

ROKIDE coatings, predominantly used as thermal barriers in rocket engines, have had many other unique electrical, thermal and mechanical properties that have met requirements on satellites from Explorer I to Friendship VII.

ROKIDE coating facilities are maintained in Norton plants at Worcester, Mass., Santa Clara, Calif., and by licensed applicators in key cities. For details, write NORTON COMPANY, Refractories Division, 282 New Bond Street, Worcester 6, Massachusetts.

*Trade Mark Reg. U. S. Pat. Off. and Foreign Countries.

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REFRACTORIES
Making better products . . .
to make your products better

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Dr. Henry Swift: Appointed director of North American Aviation's Electro-Optical Laboratory in the Space and Information Systems Div., Downey, Calif.

Charles M. Mooney: Appointed division vice president-government marketing at Radio Corp. of America's Electronic Data Processing, Washington, D. C.

C. L. McCabe: Appointed director of fleet systems support in the General Dynamics/Pomona engineering department, Pomona, Calif.

Thomas F. Dixon: Former deputy NASA associate administrator, rejoined North American Aviation, Inc., El Segundo, Calif., as assistant to the president.

William P. Peyser: Appointed general manager of Sanders Associates, Inc.'s Microwave Div., Nashua, N. H.

George M. Sokol: Appointed manager of computer programs at the eastern operation of Sylvania Electronic Systems Div. of Sylvania Electric Products, Inc., Waltham, Mass.

Robert J. Blanchard: Appointed manager of advertising and public relations for Defense Electronics, Inc., Rockville, Md.

Patrick D. Ryan: Named manager of Thiokol Chemical Corp.'s Panelyte Industrial Div. office, Cape Coral, Fla.

Sebeurn H. Fischer: Named manager-contract services at American Cable and Radio Corp., New York City.

Thomas E. Steward: Elected executive vice president of Electro-Mechanical Research, Inc., Sarasota, Fla. **Donald M. Powers** elected vice president. **M. L. Van Doren** named division general manager of the Sarasota division. **William A. Ogletree** appointed assistant division general manager. **Earle W. Wallick** appointed general manager of the Princeton, N. J., division.

William J. Grubbs: Named director of research and development of E. I. Doucette Associates, Inc., Chatham, N. J.

Allen H. Janssen: Appointed senior Air Force representative for West Coast programs for Motorola, Inc.'s Military Electronics Div., Hollywood, Calif.

Forrest H. Gehrke: Appointed manager market planning-microwave tubes Radio Corp. of America's Electron Tube Div., Harrison, N.J.

Dr. Alfred Schmitt: Appointed chief engineer at the San Marcos, Calif., branch of the Librascope Div. of General Precision's Information Systems Group.

Robert W. Harkson: Named assistant quality control engineer at OMARK Industries, Inc., Portland, Ore. **Jack C. Pattison** named quality assurance supervisor and **Everett H. Lillig** named manufacturing manager.

G. Graham Whipple: Appointed assistant general manager of Aerojet-General Corp.'s Solid Rocket Plant, Sacramento, Calif. **Dr. Werner R. Kirchner** named manager of the Solid Rocket Plant. **Ray C. Still** named manager of the Liquid Rocket Plant and **Robert Tripp** named manager of administration for the consolidated plants.

Thomas B. Quinn: Named general manager of Arnold Magnetics Corp., Los Angeles.

Edward A. Hayes: Appointed manager of Hughes Aircraft Co.'s Tucson, Ariz., engineering laboratory. **Edward J. Meyer** appointed assistant manager of the Tucson manufacturing division and **George McLaughlin** named associate manager of the engineering laboratory.

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American Society for Quality Control, Quality Control Conference, University Center, Western Michigan University, Kalamazoo, March 30.

American Chemical Society Spring Meeting, Los Angeles, March 31-April 5.

APRIL

American Rocket Society and Institute of the Aerospace Sciences, Launch and Space Vehicle Shell Structures Conference, El Mirador Hotel, Palm Springs, Calif., April 1-3.

Eighth Midwestern Mechanics Conference, Case Institute of Technology, Cleveland, April 1-3.

First Annual Oak Ridge Radioisotope Conference, sponsored by Oak Ridge National Laboratory, Oak Ridge Institute of Nuclear Studies and Isotopes and Radiation Div. of the American Nuclear Society, Oak Ridge National Laboratory, Gatlinburg, Tenn., April 1-3.

American Society for Quality Control, Annual Quality Control Conference, Sheraton Hotel, Akron, Ohio, April 6.

Society of Automotive Engineers and American Society of Naval Engineers, National Aeronautical Meeting and Production Forum, Sheraton Park Hotel, Washington, D.C., April 8-11.

Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by ASME, IAS, AIEE, IRE and University of California, Berkeley, Calif., April 10-11.

International Symposium on Optical Masers, sponsored by Polytechnic Institute of Brooklyn, Optical Society of America, IRE, AIEE and U.S. Defense Research Agencies, New York City, April 16-18.

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The Achilles Heel

SELDOM HAS ONE MAN had the impact in government that Secretary of Defense Robert McNamara has had on the Dept. of Defense. When the confusion that previously existed in the military department is taken into account, his accomplishment becomes even more monumental.

It is impossible to analyze the McNamara reorganization of the Pentagon, as the MISSILES AND ROCKETS staff has just done, without a sense of awe at the industry and efficiency of the former Ford executive.

For the first time, a Secretary of Defense is running the Pentagon in a manner directed by Congress. He is doing it so efficiently and effectively that some members of Congress have been surprised to discover just how much power they have placed in the hands of the Defense Secretary.

His reign unquestionably has been controversial. *Time* magazine has credited him with the tidiest mind in Washington, no mean compliment in an Administration which prides itself on tidy management of everything from news to desegregation. The *Saturday Evening Post* has accused him of establishing a monarchy in the Pentagon and running rough-shod over the opinions of his military advisers.

Whatever the final judgment on his tenure as Secretary of Defense, it must be acknowledged that the Pentagon never again will do business the way it did before he arrived.

What has not been generally recognized is that the Secretary of Defense has taken the statutory authority already given to him by Congress and used it ruthlessly and unemotionally to bring the Pentagon to its highest peak of management efficiency. Whether the military establishment can be run in the same way as big business is a question on which the jury is still out—and will be for some years.

Only when weapons systems now in the embryo stage reach the point where they should be operational will a full judgment of the McNamara operation be possible. The scale will be a severe one: Soviet accomplishments in the same period.

The Department of Defense grew out of the strains and cleavages in the military establishment which followed World War II. Congress, in passing the 1947 National Security Act, attempted to set up a coordinated service establishment. The Air Force was broken out as a separate executive department, and joined the Army and Navy at Cabinet level. The new Secretary of Defense was given general administrative authority, but his powers were limited by the provision which said all powers not expressly delegated to him were reserved to the services.

At the same time, the Joint Chiefs were recognized as a separate organization—although limited to a staff of 100 officers, since increased to 400.

Defense Secretary James Forrestal, after some 18 months, came to regard the plan he fathered as unworkable and recommended sweeping changes to President Truman.

As a result, Congress in 1949 amended its earlier act to set up the Dept. of Defense as an executive department, taking away the Cabinet status of the Air Force, Army and Navy. The three services were established as military departments under DOD and the Secretary of Defense was made the principal assistant to the President on defense matters. In 1953, it was further ruled that the service secretaries would have no DOD functions independent of the Defense Secretary.

The final legislative change which opened the door to today's McNamara reorganization came in 1958, when the National Security Act was further amended. This increased the responsibilities of the Secretary both in operations and research. It placed the Secretary of Defense first in command of the armed forces after the President. And it created the present directorate of defense research and engineering.

When Secretary McNamara took office, he found himself the head of an executive department and principal assistant to the President on defense matters. He possessed the power to exercise authority, direction and control over all elements of DOD and was fully responsible for the unified and specified combat commands.

It is this formidable array of powers he has employed to effect the McNamara reorganization.

WE ARE NOT ALARMED by the manner in which Mr. McNamara has used this power in military operations. The secretary seems fully responsive to his military commanders in this area. We are somewhat more concerned with the effect of his reorganization on the research and development of future weapons systems.

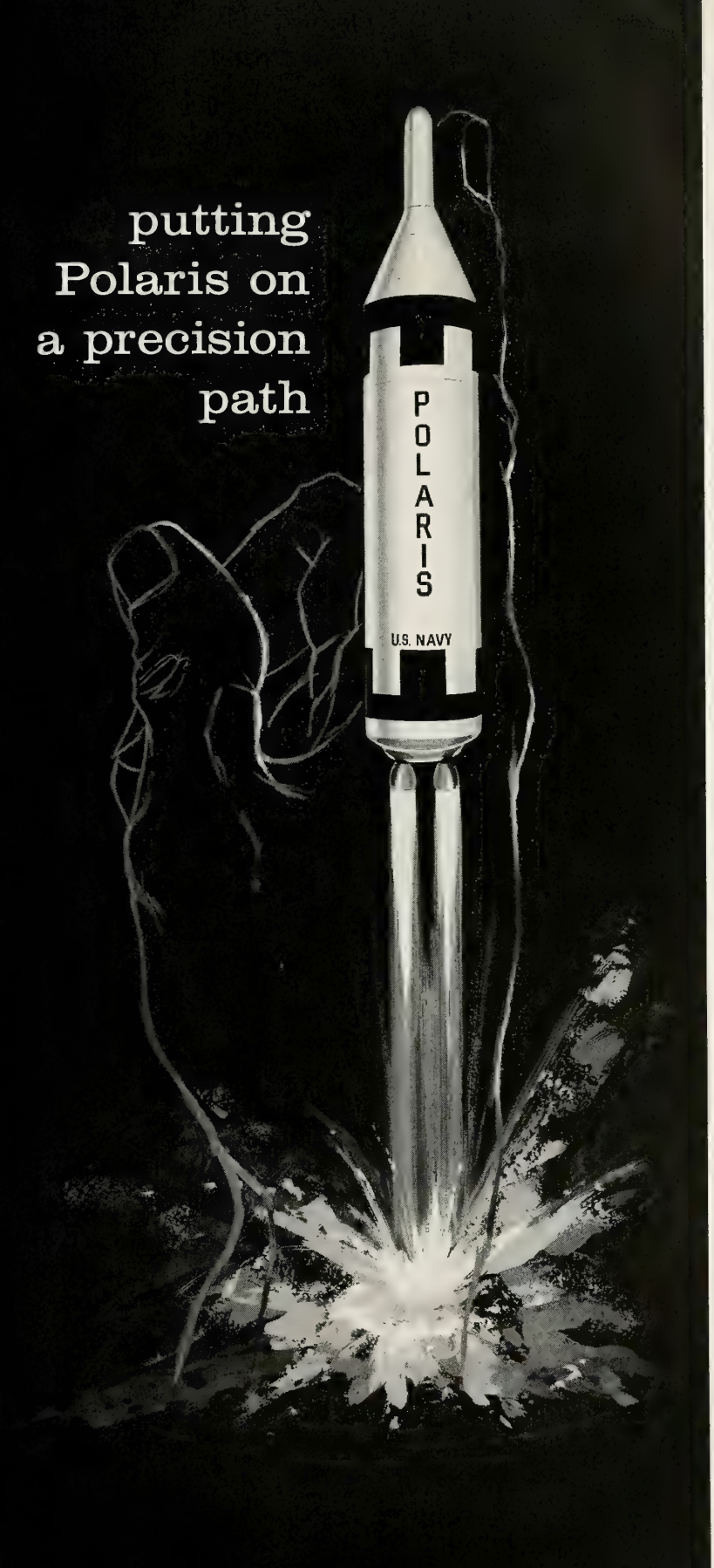
The flow of ideas and concepts on weapons systems has traditionally been from industry and the military services to Dept. of Defense level. That flow has been reversed. A member of the Joint Staff estimates that fully three-fourths of the ideas for new systems now come from upstairs—that is, from the directorate of defense research and engineering.

We are not yet fully assured that there is sufficient military and industrial input into the deliberations on research and development. We rest uneasy when we learn, for example, that Dr. Harold Brown completed his technical re-evaluation of the B-70 and recommended its cancellation without a single visit to North American Aviation.

It is true that Secretary McNamara consults with the Joint Chiefs on the military aspects of such decisions. But we would feel more secure if there was greater military/industry influence directly on DDR&E. The Secretary has said he intends to pass more of this decision-making to the individual military services when the ground rules have been firmly established. We hope he will keep a careful eye on what happens here, for we still believe the military knows more about the weapons it needs than the civilians do.

This otherwise could become the Achilles heel of a magnificently-managed establishment.

William J. Coughlin



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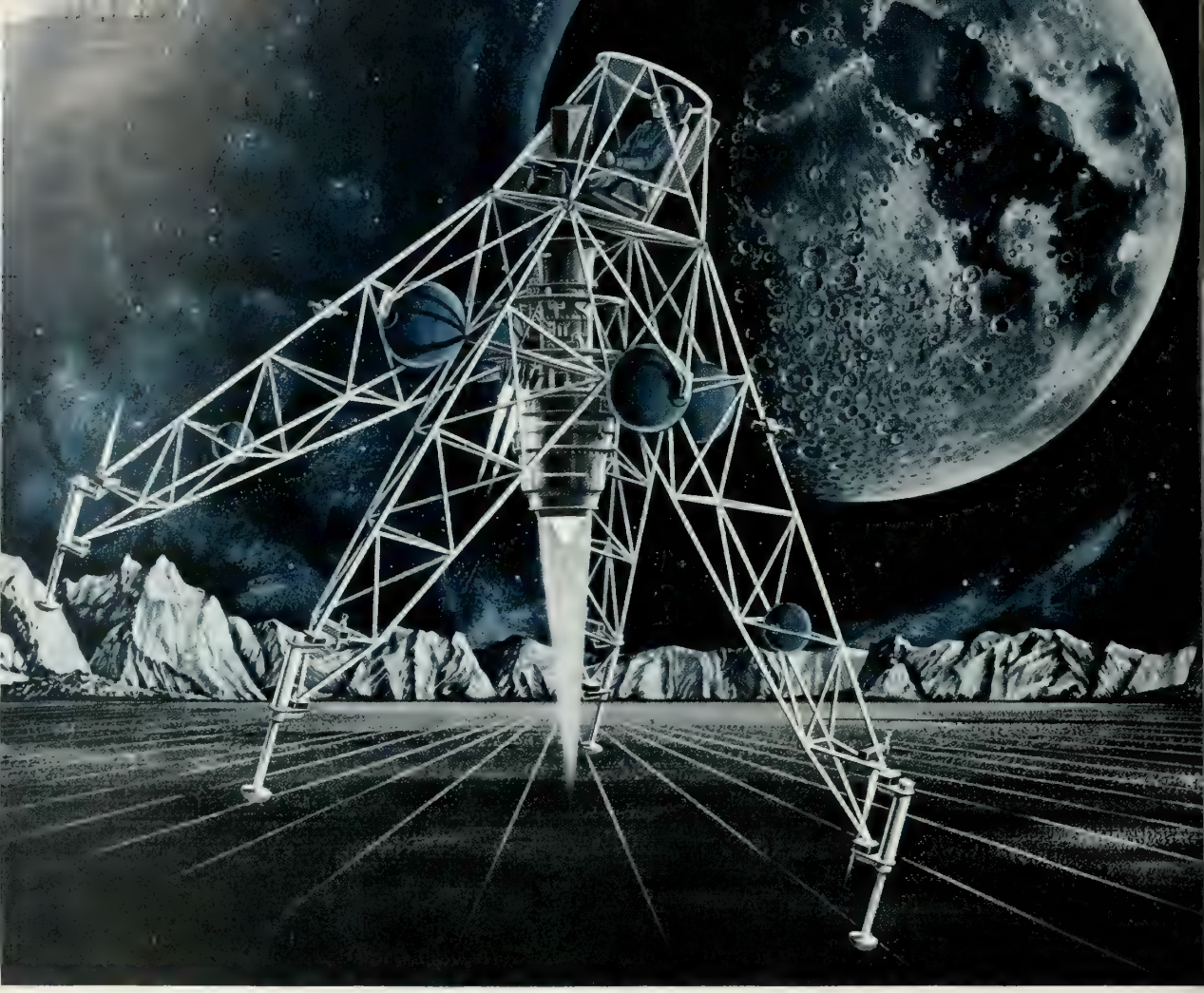
THE WEEKLY OF SPACE SYSTEMS ENGINEERING



NASA Weighing Tenth Shot In Mercury Program

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Link's Computer For Gemini Space Trainer



Artist's conception of astronaut training in Bell Lunar Landing Research Vehicle

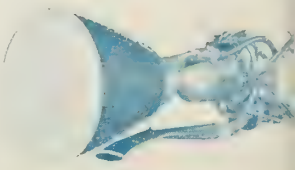
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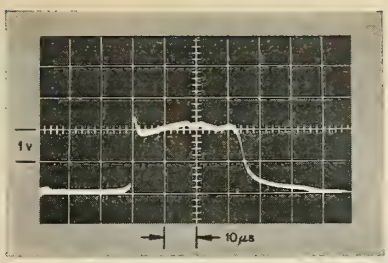


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Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

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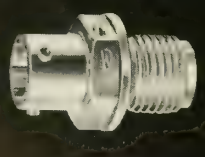
LOOK AT LOCKHEED IN FLUID MECHANICS:

Taming temperature extremes



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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 12, Number 13 April 1, 1963

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THE COVER



Gemini space-trainer computer gets checkout at Link Div., General Precision, Inc., Binghamton, N.Y., before installation at NASA centers. E. L. Sprague, senior electronics engineer, is shown overriding preset flight program. See p. 24.

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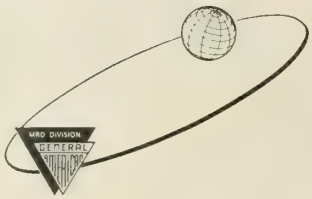
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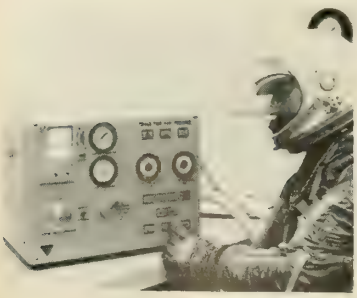
LIFE SUPPORT



• Are you concerned with keeping man alive in hostile environments? If you are, you should be familiar with the life-support equipment developed by MRD. This division has established an impressive record for conceiving and building unique life-support equipment for special applications. Present activities include research, development and fabrication of the following items:

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letters

Pride of Launch-ship

To the Editor:

In MISSILES AND ROCKETS of March 11, the cover photo shows "An ABRES Nose Cone Takes Off on *Atlas*."

Page 5 of the same issue repeats the cover picture with this notation: "*Atlas F* fired from Cape Canaveral March 1. . . . See p. 10."

On page 10 under the heading "Shots of the Week" the item gives credit to everyone involved—except that this was an *all*-Air Force capability by the *Atlas* Operations Branch, 6555th Aerospace Test Wing, Patrick AFB, Fla.

I do think our military should have equal recognition, don't you?

E. F. Geedey
Atlas Operations Branch
6555th Aerospace Test Wing
Patrick AFB, Fla.

'Appeal to the President'

To the Editor:

Your March 18 editorial, "An Appeal to the President," asks the questions that many of my co-workers and I have longed to have answered.

May your unclouded presentation of the questions be honored with an unclouded answer.

P. J. Grubl
Aerospace Industry Engineering Supervisor
Lancaster, Calif.

To the Editor:

I should like to answer your editorial.

As a Senior Research Engineer working on advanced systems concepts for a prominent West Coast manufacturer, I am in daily contact with almost all of the space programs you mentioned in your editorial. This is to neither confirm nor deny the problems you mentioned therein. But I am moved to comment on behalf of our President, whom you recklessly charged with "neglecting our national security." Nothing could be further from the truth, and I think you knew this when you said it.

Why not be objective in your editorials, point out the pros and cons and let the readers decide? We can read all the hate stories in the daily newspapers.

I am sure that our government would like to continue with all the space programs (military included), but there just isn't enough money to go around. It is my considered opinion that right now this country is facing a very serious financial crisis (gold reserves, budget, foreign aid, etc.) and our heads of government are doing a lot of soul-searching before deciding which programs to cut back. I have confidence in those heads of government to make the right decisions. If there is anything we need right now it is to succeed at something like a 1000K booster with high reliability. Believe me, there'd be no question about who's going to get there first.

So let's all try to keep our heads and not go around calling names. I think we still have a chance and I intend to do something about it. Like:

1) Work a little harder and do a little less gabbing each day at the office.

2) Try and squeeze a couple of more points out of the performance figures.

3) Try and increase reliability a whole lot more.

4) Use my spare time to better advantage by studying up on technical details I didn't have time to look into at the office.

5) Show a little more concern for the other fellow's problems.

6) Have faith.

MISSILES AND ROCKETS will do well in the future to be more objective in its editorials and less bitter.

(Name Withheld on Request)
Sunnyvale, Calif.

To the Editor:

Your editorial has particular significance for the engineers of the aerospace community. These people are in a position to appreciate the real and potential dangers of our present policy of sweeping the military space program aside.

First, the needs of the military are not the same as NASA's. The difference can represent development times of up to several years.

Second, by the time we realize a firm need it will be too late to start development.

I would appreciate a dozen copies of the editorial to post in various places.

Alan Glasser
S. Acton, Mass.

Propellant Toxicity

To the Editor:

I have previously written to you about inaccuracies in your articles that mention toxicity of propellants. Some of these statements have been so inaccurate as to make one wonder about your regard for accuracy in general.

On p. 36 of the Feb. 25 issue, in a table on the bottom of the page, there are statements that the toxicity of F_2 is serious at over 4 ppm when H_2O is present and that the toxicity of N_2O_2 (I presume you mean N_2O_4) is serious at over 7 ppm and that the presence of H_2O is influential. I suppose one could define conditions that could make your statements close to being correct, but as they stand, the statements are preposterous. Reference to technical bulletins of the manufacturers of these propellants or to "The Handling and Storage of Liquid Propellants", published by the U.S. Government Printing Office, might help.

Keith H. Jacobson
Baltimore

The table referred to is a compilation of up-to-date industry-supplied data on the toxicity of F_2 and (right, it was an error) N_2O_4. The water in vapor form the author had in mind was that which is found in the tissues of the throat and nasal passages. This could, at least in the last instance, result in the formation of nitric acid.—Ed.

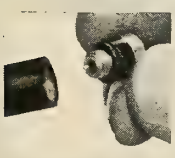
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Circle No. 4 on Subscriber Service Card →

BECKMAN BIOASTRONAUTICS...keeps up with the space age

He breathes easier now

One of the ways Beckman safeguards man in space is to protect him from blacking out from too little oxygen. Beckman meets this threat of hypoxia by testing his breathing air.

A tiny Beckman Sensor—the only one of its size accurate and reliable enough to monitor partial pressures of oxygen in closed atmospheres—travels inside the pilot's face mask or pressure helmet. Long before he detects any change in oxygen, the Sensor triggers a warning system that lights, alarms, or even speaks—telling him to take corrective action immediately.

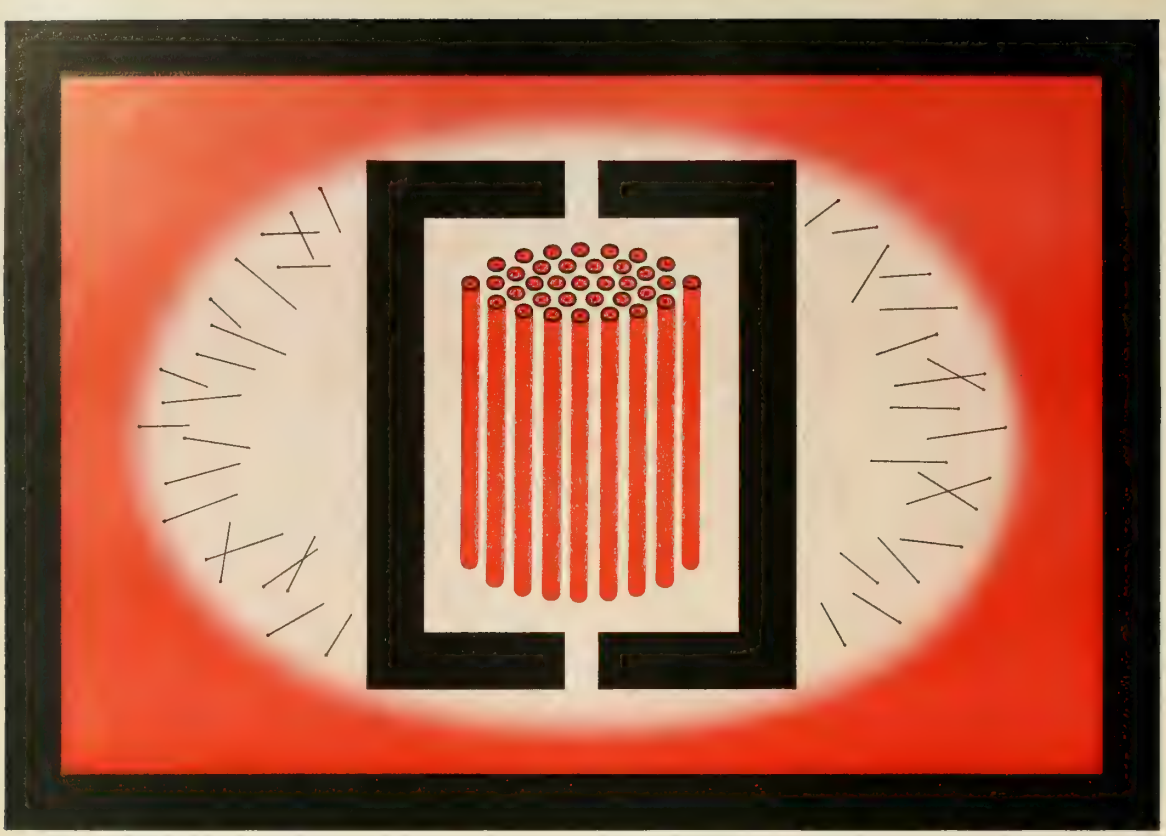


The tiny Beckman Sensor shown here weighs a scant 2 grams, but withstands 50 g's as well as severe vibration. Working on an electrochemical process, response is rapid. In less than one second it detects a change in the oxygen partial pressure. The electrolytic cell that does the work lasts up to three months. Easily calibrated in air, it can be replaced in seconds.

This is the kind of physiological monitoring hardware that has come to be expected from Beckman. For more than a quarter of a century Beckman has been testing, proving, *delivering*. With twenty-five per cent of its sales in the medical field, Beckman is solving such problems for the U.S. space agencies and its military services, the RAF, and RCAF. When it comes to *your* space-age medical problems, Beckman is one of the most qualified companies in the world. For complete information on Beckman Bioastronautics, write to Dept. M.

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2260°F FEASIBILITY OF LIGHTWEIGHT SPACE POWER SYSTEMS—AGN has successfully generated 74 watts of electricity from a thermionic cell using lithium at 2260°F pumped through a columbium loop.

4500°F SPACE PROPULSION REACTOR FUEL ELEMENTS—Economical manufacturing processes by extrusion for graphite and tungsten fuel elements capable of 4500°F operation have been reduced to practice—an AGN first.

For further information on advances in the field of nuclear materials, write for AGN Active File No. 6:

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AEROJET-GENERAL NUCLEONICS/San Ramon, California

GENERAL TIRE T.M.

The Countdown

WASHINGTON

New NASA-DOD Agreements Are Foreseen

Watch for NASA and the Dept. of Defense to sign two more space agreements before the end of the year. One will deal with the *Manned Orbiting Space Station,* the other will cover the *Atlas-Agena* launch vehicle. NASA favors the latter agreement in order to obtain responsibility for procurement as well as launching of the booster for NASA missions. This also means the space agency is getting ready to buy more *Atlas D's* for use with *Agena.*

Air Force Moves into Gemini Programming

Air Force has sent an ad hoc committee to NASA's Manned Spacecraft Center in Houston to discuss application of the *Gemini* program to AF needs. Once the joint program is well underway, Air Force will set up a permanent office at Houston for coordination with the space agency.

Navy Tests Rockets for Use in IQSY

Navy Missile Center at Pt. Mugu, Calif., is testing *Thunderbird* and *Archer* single-stage rockets to determine which will be selected for use during the International Quiet Sun Year. One will be produced in quantity to carry IQSY payloads.

Congress to Question Nimbus Management

Further Congressional criticism of how well NASA reacts to Dept. of Defense needs in the weather satellite area is expected this week. Last August, members of the House Space Applications and Tracking Subcommittee criticized NASA for allowing the *Nimbus* program to slip a full year despite its urgent need by the military services. Since then, there has been no speed-up in the program. The first launch still is scheduled for late this year. New hearings by the same committee begin this week and members are certain to ask about *Nimbus.*

New Air Force Satellite Series Set to Go

Air Force Office of Advanced Research will begin launching a new series of scientific satellites within a few months, Washington sources report. Although launch and payload details still are being worked out, the first three payloads will be in the general areas of environmental studies, life support and geophysics.

TOW Expected to Out-Perform ENTAC

Funds are provided in the Army's FY '64 budget for continued advanced development of the *TOW* heavy antitank assault weapon. *TOW's* first-round kill capability is expected to be considerably higher and its range much greater than that of current antitank missiles such as the French-developed *ENTAC.*

General Sheridan to Carry Shillelagh

The Army's new General Sheridan armored reconnaissance/airborne assault vehicle will be equipped with the *Shillelagh* missile system. Initially, the vehicle will employ conventional ammunition with the *Shillelagh* fire control system. The missile itself will be provided as soon as it is available. The vehicle also is to be produced for the Marine Corps.

NASA Sets Date for Two-Stage Saturn Launch

NASA expects to complete, late this fall, modifications to Cape Canaveral's pad 34 for two-stage *Saturn I* launches. First launch of a two-stage vehicle, however, is scheduled for late August or early September—from pad 37B.

Space Agency Pessimistic on Kiwi Problems

NASA Administrator James Webb is doubtful that the technical problems plaguing the *Kiwi* series of nuclear reactors for Project *Rover* could be solved soon even with a DX priority. Nor does he expect the troubles to be licked in time for a supplemental money request in the Fiscal 1964 budget, as suggested earlier.

INDUSTRY

Technical Seminars Worry IEEE Officials

Officials of the big Institute of Electronic and Electrical Engineers, which met last week in New York (see pp. 16 & 17), were concerned with the nine privately-sponsored technical seminars held on the side. Withholding of papers for the seminars was regarded as a threat to IEEE in its efforts to present the best technical papers. Companies concerned point out that the sessions were more up-to-date than the meeting, however, since there was no requirement to submit a draft or abstract several months in advance. An estimated 74,000 persons attended the IEEE meeting, which included more than 850 exhibits and 54 technical sessions—with about 240 papers presented.

JPL Studies Solar Thermionic Power Unit

Jet Propulsion Laboratory is studying an experimental solar thermionic power unit expected to have an operating lifetime of more than a year. Design goal: capability of generating over 250 watts near the Earth's surface and about half that near Mars.

Gemini Escape System Is Tested

Weber Aircraft Corp. is testing the ejection seat escape system for the two-man *Gemini* capsule at China Lake, Calif. Weber designed, developed, and is testing the system under contract from McDonnell Aircraft. The high-speed ejection system is designed to hurl either or both astronauts to safety while the vehicle still is on the pad, during boost or after re-entry.

INTERNATIONAL

Italian Army Will Get Cobra Missile

Germany's Boelkow *Cobra* antitank missile will be built under license in Italy for the Italian Army. Three large Italian firms—Fiat, Finmeccanica and Bombrini Parodi Delfino—have formed a company known as Sigme Societa Generale Missilistica Italiana to turn out the weapon.

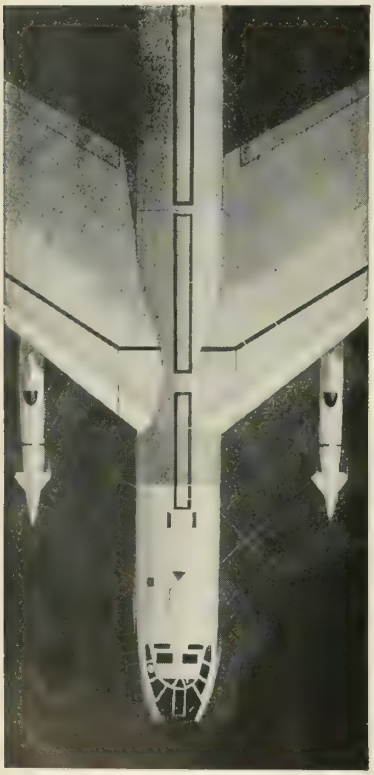
Argentina to Buy French Rockets

On-again, off-again Argentine rocket plans have crystallized with selection of the French *Centaure* rocket for certain high-altitude tests. The Sud Aviation vehicle was first introduced at Chamical Rocket Range in Rioja Province by a team of 10 French technicians.

DIVERSIFIED ELECTRO-HYDRAULICS

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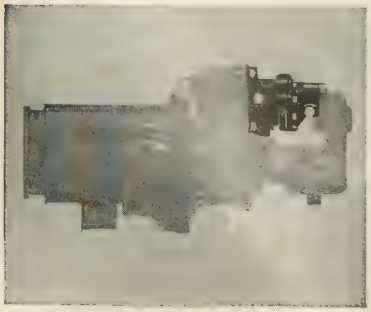
A Kellogg pump, a product of the Aerospace Division of American Brake Shoe, is an important part of the Garrett-AiResearch constant-speed drive—an efficient power source for aircraft cabin air compressors.



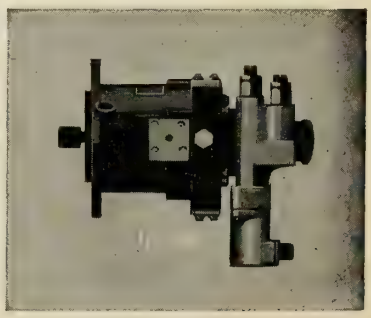
Atchley servovalves, with their exclusive JET-PIPE operation, pass contaminants as large as 200 microns without malfunction. Specified for their reliability in air- and spacecraft and for such specialized functions as driving huge antennas.



The Kellogg AP6VSC-6 pump, a single-stage, cam-actuated unit, is standard equipment on high-performance military aircraft and the Saturn I missile. The US Army's Chinook helicopter, produced by Boeing's Vertol Division, uses this pump as well as landing gear from Brake Shoe's Canadian subsidiary, Jarry Hydraulics, Ltd.







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The Missile/Space Week

Shots of the Week

Martin-Canaveral scored a double success on March 21 when it flew a *Titan II* and a *Pershing* from Cape Canaveral.

● The *Titan II* hurled a GE Mark VI nose cone into a target area 6700 miles down the Atlantic Missile Range, marking the second time the *Titan II* carried the big warhead that distance.

The GE Mark VI is the largest nose cone in the country's arsenal. It is double the size of the *Titan I* nose cone, four times as large as those carried on *Atlas* and 14 times the size of the *Polaris* and *Minuteman* re-entry vehicles.

After the successful flight, the Air Force admitted for the first time that the *Titan II* has a reaction time of less than one minute—similar to that of solids, such as the *Minuteman*.

● The *Pershing* was sent on March 21 on a long-range test flight from a mobile transporter-erector-launcher under simulated tactical conditions.

A full set of tactical ground-support equipment was used to prepare and fire the missile in its last R&D launch. Additional *Pershings* will be fired from the Cape as part of *Pershing* Project 4—a series of launches to train Army crews for tests to be run at White Sands Missile Range in New Mexico. *Pershing* is scheduled to be deployed in Europe later this year.

● Three Army *Sergeant* missiles were successfully launched on March 18, 20 and 21 from San Nicolas Island against Pacific Missile Range targets in the Santa Barbara Channel islands. Goals of the series were to see if the missiles could endure land, sea, and air transport; to evaluate the effects of salt air and low altitudes; and to test the guidance system. *Sergeant* battalions are about to be deployed overseas; a West German Army battalion recently completed *Sergeant* training in the U. S.

● An *Atlas F* ICBM fired from Vandenberg AFB marked the fourth successful flight of a major U. S. missile on March 21 when it streaked more than 4000 miles down the Pacific Missile Range. Chief test objectives were to evaluate the overall operational weapons system, including the airborne vehicle as well as aerospace ground equipment. Preliminary telemetry showed that the re-entry vehicle impacted the target area.

● Another *Atlas F*, launched from Vandenberg on March 23, exploded shortly after liftoff.

● Last of the interim Wing II *Minutemen* was launched from Cape Canaveral on March 27 on a flight of more than 4000 miles. This was the last of the series of four of these interim missiles, a combination of Wing I and Wing II designs.

● The Soviet Union sent *Cosmos 13* into Earth orbit March 21 to gather space data for future manned flights. It was the first Russian satellite successfully launched in 1963. *Tass* gave out the following orbital statistics: initial orbiting period—89.77 min; apogee—209 mi.; perigee—127 mi.; inclination to equator—64°58′.

RCA Asks ComSat Role

A Radio Corp. of America subsidiary, RCA Communications, Inc., has applied for authorization to purchase stock in the Communications Satellite Corp.

The firm, which now operates a world-wide system of radio and cable circuits, said in the petition that it also expects to provide international services via satellite systems when they become available.

The Communications Satellite Corp. may be ready to start its sale of stock early next year.

This prediction was made by Bruce Sundlun, a ComSat Corp. official, in a speech to the Magazine Publishers Assn. in Washington, D. C.

Sundlun said early 1964 is a target date for the corporation, but he noted that there are many technical questions that remain unanswered, and no one can say just when the answers will be found.

The number of satellites that will do the job best, the most desirable orbit and the types of boosters best suited to orbiting the ComSats are all unknowns but are under study, Sundlun said.

The official also stressed the financial hurdles confronting establishment of the corporation as a working group. He pointed out that the corporation will be making the largest public stock offering in U. S. history.

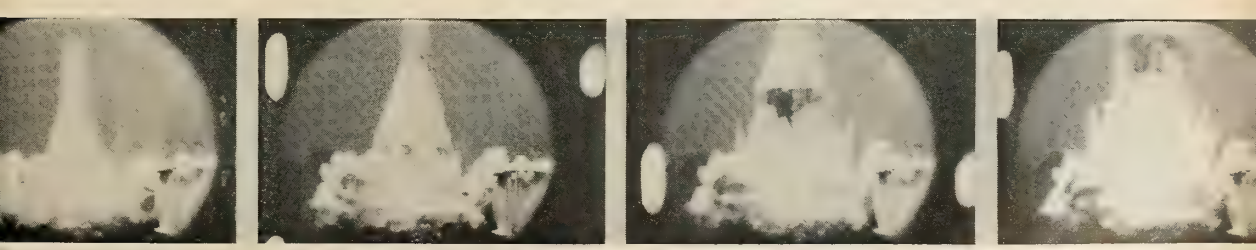
Apollo ECS Tests Begin

An important milestone was marked last week in the development of the *Apollo* environmental control system (ECS) when first tests of the system began at Garrett-AiResearch, Los Angeles.

System development testing of the ECS will continue for approximately six months.

Paul C. Scofiel, AiResearch *Apollo* program manager, said the test profile will include simulating pre-launch, ascent, orbital and re-entry pressure conditions on an operating environmental control system. Function of the system is to provide life-supporting atmosphere in the Command Module of the *Apollo* spacecraft.

Development testing of the ECS will be conducted in a new laboratory facility built especially for the *Apollo* Program. AiResearch is developing the system under contract to North American Aviation Inc.'s Space and



Underwater Polaris Firing

FIRST RELEASED photos of recent launch of Polaris from submerged USS Theodore Roosevelt off Atlantic coast of Florida. Low-angle Photosonics camera, packaged by Interstate Electronics Inc., was mounted in capsule between tube hatches.

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Information Systems Div., prime contractor to the Manned Spacecraft Center for the NASA *Apollo* vehicle.

The new laboratory is composed of a programmed-altitude chamber, and an array of auxiliary test-support equipment, such as heat exchangers, vacuum pumps and refrigeration units.

A unique feature of the test lab is its data acquisition system, one of the most comprehensive ever devised for development of an ECS.

Polaris Subs to the Med

The first of several *Polaris* submarines earmarked for operations in the Mediterranean is expected to be on station there this week, the State Department has revealed.

Lincoln White, State press officer, said it was "no secret" that three of the vessels will be assigned there.

Long-scheduled dismantling of the *Jupiter* nuclear missile bases in the area is scheduled to begin shortly after deployment of the submarines.

Negotiations have been under way for months to locate berthing facilities for the subs in the Mediterranean. But White said ports for the subs will continue to be at Holy Loch, Scotland, and at U.S. bases, for the time being.

Boston Center Cost-Cut Eyed

NASA is considering an alternative concept for its Electronic Research Center which would reduce its land requirements.

Administrator James E. Webb told the House and Senate space committees that the space agency is now thinking of building one or more multistory buildings on land owned by the Massachusetts Turnpike Authority. Previously, the space agency said the $50-million center would require about 1000 acres.

The authority land is located in the greater Boston area near its university and industrial complex.

Titan III Complex Bids Set

The Army Corps of Engineers has called for bids to be opened May 8 for the first package of construction on the $10-million *Titan III* launch complexes at Cape Canaveral.

The bids will cover construction of two 600-ft.-dia. circular pads with launch stands, a 240-ft.-tall, 3.5-million-lb. mobile service tower for each pad, railroad tracks for the towers, two 170-ft. umbilical masts with 13 sliding platforms, support buildings, fuel areas and other minor facilities.

Additional bids will be called for later to cover utilities, railroad and transporter trackage, receiver buildings for vehicles and boosters, vertical integration building and roadways.

Due to the critical nature of the work and the tight schedule, only pre-qualified contractors will be permitted to bid on the work.

Dredging already is under way for the *Titan III* complexes.

Antitank Missile Urged

A small tank-killing missile is the greatest need in the U. S. weapons arsenal today, says Gen. Paul D. Adams, commander of the newly created U. S. Strike Command.

Gen. Adams, speaking at charter ceremonies of the Florida Peninsula Post of the American Ordnance Assn., Orlando, said that such a missile "would do more to enhance the efficiency and mobility of the foot soldier than any other weapon."

The weapon, he said, would have to be small enough to be carried on and fired from a jeep, and would have to be effective at ranges of 1000 yards.

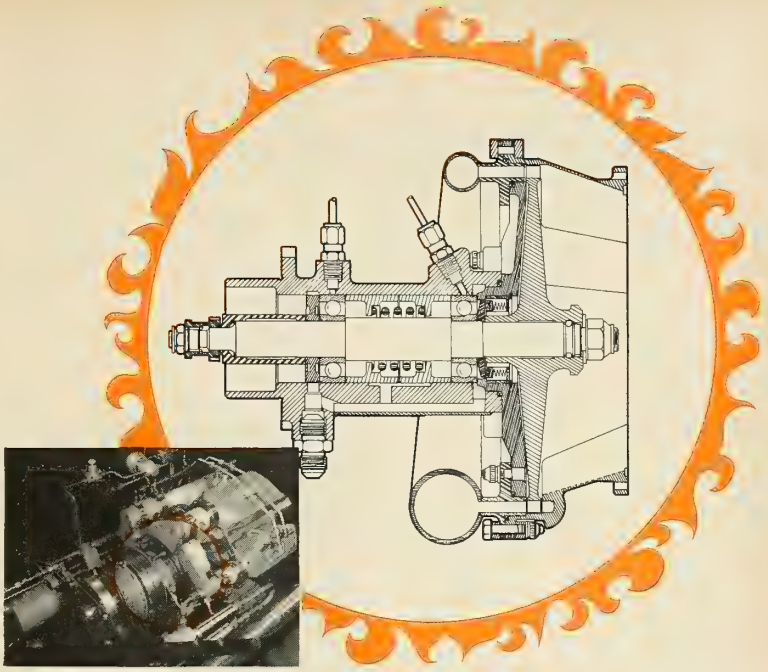
He said he found it difficult to understand why a country that had the brains to develop a space vehicle capable of measuring the temperature of Venus apparently was not able to produce a small mobile missile that could destroy a tank.

N.Y. Reactors Nearer

One of two major programs to build new advanced-type nuclear reactors in New York moved into the contract stage last week, while the other is said to be very close to initiation.

American Machine & Foundry Co. and the Western New York Nuclear Research Center, a subsidiary of the State University at Buffalo, entered into a joint cost-sharing contract which aims to place a new reactor in operation on the university's campus by late this year.

Officials in the New York State Office of Atomic Development, backed by several leading electronics firms in the state, also are pushing ahead with plans to build a very-high-power pulsed reactor plant (M/R, June 18, p. 36). The device probably will be of the "Super-Godiva" type, with "no less than the characteristics of the Fast Burst, or Health Physics, Reactor now in operation at Oak Ridge." This type of device will provide higher power pulses, higher neutron flux and shorter pulse widths.



THIS HIGH SPEED ASSEMBLY UNAFFECTED BY EXTREMES OF ACCELERATION AND TEMPERATURE

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Four-day flight . . .

NASA Weighs MA-10 Possibility

Although officials say it is not likely, extra shot might fill pre-Gemini gap—and surpass present Soviet flight records

by Hal Taylor

THE UNITED STATES is considering another Project *Mercury* shot which could wrest away from the Soviet Union world leadership in manned spaceflight.

The *MA-10* flight would send an American astronaut whirling around the world for as long as four days—96 hours.

This would eclipse the two longest flights chalked up to date, both by the Soviet Union—the over-64-orbit flight of Cosmonaut Maj. Andrian Nikolayev, which lasted just under four days, and over-48-orbit flight of Cosmonaut Lt. Col. Pavel Popovich, which lasted just under three days.

MA-10 would require a major modification of the current *Mercury* capsule. A canister would be secured to the end of the capsule by the heat shield reentry packet. The canister would hold additional oxygen and water for the life support system, hydrogen peroxide for the attitude control jets, and batteries for the spacecraft power requirements.

This would be jettisoned along with the retro pack after the capsule reentered the Earth's atmosphere.

A NASA spokesman admitted that the flight is being considered. No decision will be made, however, for four to six weeks after the *MA-9* flight of Astronaut L. Gordon Cooper. This now is scheduled for no earlier than May 14.

The official said that at this point he can see little chance that the flight will be attempted. It would be attempted, he continued, only if *MA-9* is unsuccessful or does not provide all the data which scientists hope to obtain from it.

● **On the agenda**—It has been learned, however, that the Atlantic Missile Range has an *MA-10* flight scheduled for September. It is also known that modifications to a *Mercury* capsule for the flight are being made at the McDonnell Aircraft Corp., prime contractor for the project. NASA's Manned Spacecraft Center at Houston has also begun the procurement of the miscellaneous flight items needed.



NASA ARTIST'S conception of modified Mercury capsule envisioned for MA-10. Canister with added life support equipment would be secured by heat shield.

While all this could simply be exigency, an *MA-10* flight has two important attractions to the space agency.

One involves the gap between the *Mercury* and *Gemini* programs. If *MA-9* goes on schedule in mid-May, there may be as much as a full year of delay before the first manned *Gemini* orbital flight can be made.

Although it is still officially scheduled for the first quarter of 1964, the *Gemini* shot is far more likely to go in middle of the year. *MA-10* would enable the *Mercury* team to maintain operation efficiency until switching over to the *Gemini* program.

The other attraction is the possibility of finally catching up with the Soviet Union lead in manned spaceflight.

This hope, however, is somewhat tenuous. With the advent of spring in the Soviet Union, U.S. scientists expect that nation to pull off another space spectacular. It is conjectured that the Soviet Union will either place a female in orbit or accomplish rendezvous between two orbiting spacecraft. Either could mean a flight lasting much longer than four days.

● **Mercury-Atlas 9**—Meanwhile, preparations continued for the 22-orbit, 34-hour flight of Cooper in mid-May. Officials maintain that tests and checkouts on the spacecraft thus far have gone perfectly.

One task calls an attempt to photograph the phenomenon of zero zodiacal light.

In other experiments of similar vein, Cooper will:

—Attempt to photograph the setting Moon, in order that the altitude of the horizons may be fixed with greater precision for space navigational purposes.

—Attempt to photograph a jettisoned balloon to determine a measurement of a descending visual threshold in space.

—Try to determine the range at which a flashing light can be detected under various solar illumination conditions.

—Take colored photographs to obtain further information on the feasibility of using airglow bands to locate the East horizon position. ■

McNamara Spells Out AF Gemini Role

Secretary testifies that satellite interception could become one mission after takeover of program

by Frank G. McGuire

DEFENSE SECRETARY McNamara foresees possible Air Force use of *Gemini* spacecraft for inspection and interception of enemy satellites.

This is one application which could result from an expected AF takeover of the *Gemini* program, the Defense chief told a House Appropriations subcommittee in testimony on the Fiscal '64 budget.

He said a total of $68 million is involved in the *Satellite Inspector* and *Satellite Interceptor* programs, mostly in hardware, and that realignment of these, as well as *Dyna-Soar*, might fit into the *Gemini* program.

Commenting on the savings to be realized by concentrating on *Gemini* instead of *Dyna-Soar*, the Secretary of Defense said hundreds of millions of dollars, and "probably billions of dollars over the next several years," would be saved.

The Secretary's bluntness in describing the temporary nature of NASA's interest in *Gemini* and a probable Air Force acquisition of the program surprised many observers.

Indicating that he is trying to convert some adamant AF planners to his way of thinking, McNamara said:

"I think that after the Air Force fully understands the *Gemini* project and is acquainted with the extent to which the *Gemini* project may add to the Air Force's knowledge of manned flight in space, and the extent to which perhaps the *Gemini* project can be modified with relatively slight effort to better meet the Air Force's needs for capabilities in manned space flight, it may be possible for the Air Force to cut back the *Dyna-Soar* project substantially."

He noted, in just-released testimony delivered in February, that he had, at that time, already asked the Air Force to "consider cutting back the *Dyna-Soar* and proceeding with the *Gemini*."

Preview of *Gemini* as ultimately an all-Air Force program came during the appropriations hearings when McNamara said NASA "developed *Gemini* as a step toward their manned lunar landing and as such they have only a limited interest in *Gemini* itself . . . The Air Force, on the other hand, is concerned about the possible use of man in the same environment, near-Earth orbit, for potential military purposes."

He noted that he alone was the originator of the idea for a NASA/DOD agreement on *Gemini*, and that he did so specifically to eliminate manned spaceflight duplication. In this light, McNamara said he cut military space requests from $2.274 billion for FY '64 to $1.688 for 29 separate projects. Two of these cancelled requests, for an AF *Blue Gemini* program and *Manned Orbiting Development Station (MODS)*, totalled $177 million.

● **Gemini management**—McNamara tossed cold water on the impression that AF is a poor relation in the *Gemini* program. Defining the word "management" and its scope, he told the subcommittee:

"Insofar as management normally includes responsibility for planning, it is not solely, or even primarily, in the hands of NASA, because the agreement specifically provides that *Gemini* will be a jointly planned project, planned by the Defense Department representatives and NASA. Therefore, to that extent, its management is not primarily in the hands of NASA. . . In a sense, the Air Force is managing the project and NASA is not. NASA is using the Defense Department as its contracting agency on a wide variety of its projects. I believe it covers *Gemini*."

He added that DOD did more than $550 million worth of work for NASA in 1962, mostly on a reimbursable basis, and expects to contract for NASA to the extent of about 5000 man-years worth of procurement in the coming period. In the sense of managing procurement for NASA programs, McNamara commented, DOD has a tremendous management responsibility.

In addition, he said, DOD agencies such as the Air Force are managing most of the bioastronautics laboratories and facilities on which *Gemini* will depend for a very substantial part of its program. Nevertheless, he dismissed possible controversy over exactly who is managing what as "a play on words."

● **Bomb-in-orbit**—In discussing the requirements for military operations in space, McNamara said it is not certain that a manned vehicle would be required for inspection purposes or other duties in space, in part because "a man greatly complicates the operation in space. You have to put so much in space just to allow a man to exist that it greatly adds to the complexity of the operation. Today it appears to us we can achieve military capabilities in space more quickly without a man than with a man."

But, he said, the U.S. must be prepared for all eventualities.

"Furthermore, we are constantly appraising the potential military usefulness of a warhead in space and should we find any situation in which there does appear to be a military advantage in having a warhead in space we want to have the capability to put one quickly in space. That we are working on." ■

Titan III To Survive X-20

CANCELLATION of the *X-20 Dyna-Soar* is not expected to affect *Titan III* seriously. As Defense Secretary McNamara put it: "*Dyna-Soar* depends on *Titan III*, but *Titan III* does not depend on *Dyna-Soar*."

Designed to put between 6000 and 25,000 lbs. into Earth orbit, *Titan III* is in a technical competition with the *Saturn C-1*, a booster of comparable capability but higher cost and slower reaction time. DOD wants the *Titan III* as a standard launch vehicle, and as such, it is not intended solely for *Dyna-Soar*.

Dyna Soar would not take up more than 10% of the *Titan III* requirements, McNamara told a House Appropriations subcommittee, but if the booster's costs get out of hand —in a manner similar to *Skybolt*— he may very well recommend cancellation or cutback of the program.

Studies on *Titan III* are now being undertaken by DOD and are expected to be complete in May or June. If these studies indicate that costs are being held to tolerable limits, the booster will go into final development phase.

X-20 Energy Display System Described

GPI engineers outline program at gathering attended by 74,000; Kollsman reveals new daylight star tracker

by Michael Getler

NEW YORK—First details of the Energy Management Display Indicator for the Air Force *X-20 (Dyna-Soar)* program, and a new system for improved daylight star tracking were revealed before the Institute of Electronic and Electrical Engineers here last week.

The *X-20* EMDI program was outlined in a presentation by H. T. Vagt and H. N. Oppenheimer of the GPL Div. of General Precision, Inc. GPI holds a contract from the *X-20* prime, Boeing Co., to develop this device.

In effect, the EMDI presents the pilot with a real-time cockpit display of the kinetic and potential energy of the vehicle in relation to safe operating limits, primarily during boost and re-entry flight.

An analog situation display, derived from vehicle sensors and computers, is presented on a 5-in. cathode ray tube to provide a real-time view of spacecraft performance. To allow the pilot to compare actual conditions with anticipated performance, a series of film overlays is used, reflecting the pre-programmed parameters and allowing visual comparison between the CRT and film displays.

The GPI device includes 48 film overlays, which can be changed manually or programmed automatically to follow flight progress. Film frames, according to GPI, are identified by an ID code punched into each frame. The code is read by sensing elements on the indicator and the output transmitted to the vehicle computer to insure correlation between the CRT data and the film overlay.

The EMDI operates in three modes:

1) **Boost Profile Mode**—used from launch until burnout of final stage. During this period the pilot is provided with a CRT display of altitude vs. rate of change of altitude, with the overlay showing nominal upper and lower limit conditions. A vernier display is also available to aid pilot control of proper boost rocket cut-off. This display is not automatic, engineers point out, since the vehicle may be operating outside vernier limits.

2) **Flight Integrator Mode**—used during re-entry to indicate instant limit conditions and predict impending difficulties. This mode plots altitude vs angle of attack on the film overlay. Each film has a band of altitude values scaled for a particular range of velocities, with limiting vertical velocity values shown for each altitude line. In both modes 1 and 2, actual vehicle condition is represented by a single dot on the CRT.

3) **Energy Management Display Mode**—also used during re-entry to select a landing site. In this mode, GPI reports, the overlay consists of a series of intersecting curved lines which indicate angle of attack (AOA) and angle of bank (AOB). A number of dots, up to ten, are displayed on the CRT, each representing a potential landing site. As the vehicle moves, so do the computer-plotted dots. The location of any dot indicates the AOA and AOB to be maintained to reach that site. Each dot has an associated number which corresponds to a specific landing area. The pilot then selects the site via a switch on the control panel. Simultaneously, this selection is transmitted to the vehicle computer, which returns a signal to the indicator causing a circle to appear around the CRT dot chosen. This indicates confirmation of site selection.

GPI reports that the accuracy of dot or circle positioning within a 4-in.-diameter circle on the CRT is ± 2% of a radius anywhere on the CRT face. Both X- and Y-axis channels employ two highly stable d-c amplifiers separated by a CRT flat-face correction network. Residual pincushion errors are corrected by magnets cemented to the CRT envelope.

The film overlay frames are 4½ in. sq. They can be changed automatically within two seconds with a reported frame-to-frame registration of .010 in. Also provided are: automatic stops to limit film travel; a manual changing device; and a sensing system that provides a 12-bit ID readout to the *X-20* computer. A Geneva Star-Wheel movement is used for film transport.

The EMDI, according to GPI, weighs less than 25 lbs. and average power consumption is less than 70 watts. GPI reports that the EMDI project is now in the qualification phase, with the prototype development phase completed. The unit reportedly met all performance requirements with a computed MTBF in excess of 1200 hours.

● **New daylight star tracker**—John W. Barnes and John Goodlet, Jr., of Kollsman Instrument Corp. revealed certain details of what could be a way to vastly improve missile/space guidance system capabilities for daylight star tracking.

The Kollsman system uses a multi-element surface-junction silicon sensor which, under very high illumination levels, reportedly offers "decided advantages for daylight tracking over a photomultiplier device." The engineers claim that under practical operating conditions the silicon device would yield S/N ratio improvements of 1-15 times that of S-4 type photo-multipliers for daylight star color temperatures ranging from 3000 deg. K. to 11,200 deg. K. Approximately 70% of the navigational stars fall into this category, they report. The system, at this point, offers no advantages for low-light-level operation.

The engineers, who report the firm has already built and delivered one of these systems to a prospective customer, told MISSILES AND ROCKETS that the silicon device would have major significance in a space application since it requires no power supply (the photovoltaic cell generates its own power), and the complete system including optics (but not gimbals) can fit into a 4-in.-by-4-in. cylinder. The small size will also contribute to better acceleration behavior. Boost phase guidance is considered as likely for missile applications.

Though exact design details are proprietary, Kollsman did reveal that the heart of the device is the multi-element silicon cell (two concentric sensitive areas are used) which is encapsulated in a TO-5 can containing clear glass windows. The multi-element silicon circuit design is primarily aimed at canceling sky-background-generated signals. ■

Laser R&D Cost: $25 Million a Year

Panel reports on six major possible applications, warns that practical optical communication is far in future

by Charles D. LaFond

NEW YORK—The U.S. effort to develop laser technology is costing roughly $25 million per year.

The Government is providing about 60% of the funding, and some 600-700 scientists and engineers are engaged in this broad national research program.

These estimates, by Dr. R. H. Kingston of MIT's Lincoln Laboratory, were disclosed at last week's annual convention of the Institute of Electrical and Electronic Engineers. Kingston was one of five panelists in a jampacked session at the Waldorf-Astoria Hotel titled "Optical Masers—Workhorse or Playboy?"

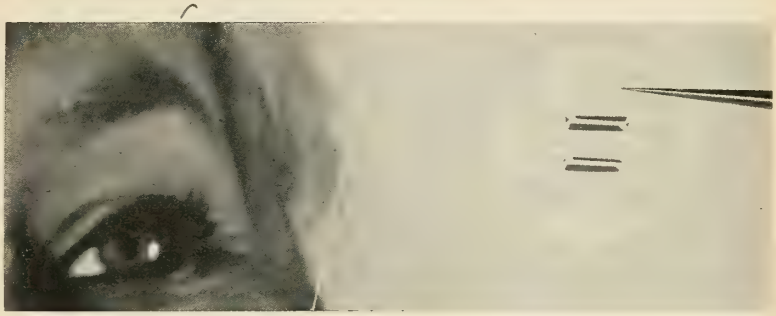
The panel, chaired by Dr. C. H. Townes, provost of MIT, also included Dr. A. L. Schawlow, Stanford Univ., and Dr. R. H. Kompfner, Bell Telephone Laboratories

A rough breakdown as to the division of effort, Kingston suggested, might be as follows: Devices and techniques—40%, basic study of materials—25%, actual applications—20%, associated optical components—10%, and material improvements—5%.

● **Major possibilities**—Although at least a dozen possible applications for lasers were noted by Smith, the scientist placed heavy emphasis on the following six:

—*Pulse ranging*—Optical radar employing very short, high-power pulses. A recent Hughes development for short-range use was shown by Smith in the form of a portable, rifle-type device for field use. Weighing 44 lbs.—including 33 lbs. for the backpack power supply—the instrument fires a 0.2 milliradian beam against all conceivable targets up to seven miles distance, he said. It has been used in light rain for up to three miles. Larger fixed equipment, he pointed out, may someday be used to study the lunar relief. Also, because of the inherent capability of laser systems to measure small changes in distance, they could become a powerful tool for performing precise surface-contour alignment.

—*Communications*—While possibly the most important application for the future, beam acquisition and atmospheric interferences still offer severe obstacles to practical use.



BLONDE HAIR is ten times as thick as wafer-like "thin-film" electronic circuit shown by Hughes Aircraft Co. at IEEE meeting. Featherweight wafer, which would be almost invisible viewed edgewise, is said to encompass "fully integrated" circuit.

—*Welding and micromachining.*

—*Medical uses*—Including retina welding, cauterizing and surgery. With high power pulses of short duration, there is no damaging thermal transfer into surrounding areas.

—*Scientific research*—Including emission spectrographic analysis, interferometric ranging—changes down to one wavelength at 10,000 miles are possible in distance measurements, he said—and rotation-rate sensing.

—*High-speed photography and telephotography*—High-speed motion pictures have been taken recently, Smith disclosed, with 30 nanosec. pulse lengths at a rate of one half million frames per sec.

● **Limitations ignored**—Expanding on the communications application, Kompfner stressed that practical optical communications are a "long way off." The trouble is, he asserted, that many have given in to the temptation to extrapolate from today's highly developed microwave technology to the optical region without really recognizing the limitations.

He predicted two major future applications: Outer space beyond the Earth's atmosphere and long-distance Earth transmissions through some form of light pipe.

Present laser development in the components area is so rapid, Kompfner declared, that systems development is impractical. ■

'Moon Bounce' Telecommunications

USE OF lunar bounce for telecommunications offers up to a 100-fold improvement in speed, capacity and power requirements over other passive means.

It also provides 6-10 hours of continuous visibility from Earth, compared with the 30 minutes of useful availability of *Echo*-type *Relay* satellites, says S. E. Kasowski, of Martin-Orlando Div.

Speaking at the IEEE convention, the engineer described a system capable of operating at various power levels and within a broad frequency band (1 mc). Dubbed Rake, the technique was developed specifically to transmit digital data point-to-point between radio terminals several thousand miles apart.

Present FM Moon relay links, he claimed, offer only a few teleprinter channels of capacity. The Rake approach, using a pseudonoise technique could provide 50,000 bits per sec. capacity at the same frequency with equal fidelity, he asserted.

Further, the pseudonoise waveform offers a highly secure method of transmission.

Cosmos May Have Photographed U.S.

NASA's Dryden says Russians told him of weather satellite experiments; joint weather, communications work agreed on

THE SOVIET UNION has been taking cloud cover photographs with its *Cosmos* satellite series—perhaps over the U.S.

Dr. Hugh L. Dryden, deputy NASA Administrator, said last week Soviet scientists told him they had been conducting weather satellite experiments with the *Cosmos* series.

"The inference was that they had been taking pictures of cloud cover," Dryden said.

He added that he "didn't know where" the pictures were being taken, but the clear implication was that the area may conceivably have included the U.S.

Dryden's comments were made as he revealed details of recent U.S.-USSR arrangements for space cooperation.

The major area of agreement calls for both nations to launch weather satellites in 1964 and establish a direct telegraphic link between Moscow and the U.S. Weather Bureau facility at Suitland, Md.

Other major results of the Rome, Italy talks between Dryden and the top Russian negotiator, Academician Anatoly Blagonravov:

—Joint communication experiments will be conducted via the *Relay II* passive communication satellite.

—It was decided to continue discussions of coordinated launchings of satellites to measure the Earth's magnetic field during the International Year of the Quiet Sun in 1964.

—U.S. scientists connected with the *Mariner II* Venus spacecraft and Russian scientists concerned with the Soviet Mars probe will assemble at the COSPAR meeting in Warsaw this June to discuss their respective projects. Both sides are expected to read papers at the meeting. Dryden said he hopes the discussions will lead to coordination of experiments on interplanetary problems.

● **Weather plans**—The NASA official said the agreement calls for each nation to maintain a working weather satellite continuously. He said that while the Soviet Union still can not match U.S. capability in this area, they apparently expect to in 1964.

He said that while the U. S. probably will use the *Nimbus* weather satellite in its contribution to the agreement, the Russians did not say what type of satellite or what kind of weather coverage they would provide.

The communication link between the U. S. and USSR will be used to transmit cloud cover pictures taken by each nation's satellites with sufficient speed so that meteorologists in both nations can use them for weather forecasts. Dryden said the transmission will be made within about six hours.

The agreement specifies that the communications link is to be a four-wire, full-time link capable of facsimile transmission. Testing and installation of the line will begin in early 1964.

It was agreed in principle that there would be an equal sharing of the costs of the link, but final business arrangements have not been completed.

In addition, it was agreed that any other country could have access to the communications link on a receive-only basis. The countries would have to pay a proportionate share of the costs, but would have available for their use all information transmitted.

Dryden discounted the possibility that the link could be used by the leaders of the two countries as a so-called "hot line" in any cold war emergency. He pointed out that the Russians made it clear they did not want the link used for political purposes.

Turning to the communication experiments, Dryden said the low altitude of *Echo II* will preclude simultaneous visibility of the satellite between the U.S. and USSR. This necessitates an intermediary which will be the Jodrell Bank at the University of Manchester in England. The Russians will operate from their Zimenky Observatory of Gorki State University. ■



First U.S. Lunar Exploration Targets

A NASA OFFICIAL reported last week that the United States has selected two areas for its initial exploration efforts on the Moon's surface. Dr. Eugene M. Shoemaker, a space agency astro-geologist, said the two regions are the crater named Copernicus (arrow at left) and the 100-mile-long, one-mile-wide Ariadeaus Cleft (arrow at right). The Copernicus Crater is near the planned impact area for NASA's unmanned Ranger hard-landing spacecraft.

SA-4 also scheduled at Cape . . .

S-6 To Study Particles, Drag Effects

Delta-boosted satellite should enrich knowledge of atmosphere and spacecraft orbital characteristics

NASA PREPARED a 405-lb. satellite for launch last week in an attempt to gather information on the atmospheric structure and on spacecraft orbital characteristics at altitudes of 155 to 580 miles above the Earth.

The launch of the *S-6 Atmospheric Structure Satellite* was scheduled as part of a space agency double-header at Cape Canaveral on March 28. Coupled with it was the fourth development flight of the giant *Saturn I* booster (M/R, March 25, p. 20).

The *Saturn* shot will test for the first time the engine-out capability of the big 1.5-million-lb.-thrust booster.

Primary mission of the *S-6* satellite, launched by a *Delta* booster, will be the measurement of neutral particles in space by two mass spectrometers.

Space agency officials said that if the satellite transmits data for only two days, it will more than double existing information on the particles. However, *S-6* also is expected to provide new information on the effects of high-altitude atmospheric drag on orbiting spacecraft as well as re-entry vehicles on their way back to Earth.

This will be gathered by four vacuum tubes and two electrostatic probes which will measure temperature and pressure during the satellite's orbit at high altitudes.

The *S-6* launch can only be made during a three-hour period each day. On March 28, the period was between 9 p.m. and midnight, EST. Each day thereafter, the "window" slipped about four minutes. The night-time launch is required so that an Earth sensor used for satellite attitude control will not accidentally acquire the Sun and be damaged by the intense solar radiation. A second sensor is provided to initially "lock on" the Moon, and later switch onto the Sun to provide Earth-Sun or Earth-Moon two-point references for correlation of scientific data.

• **Thin-skinned**—the S-6 is a spherically shaped 35-in-dia. satellite with a stainless steel shell only 25-100ths of an inch thick.

It is to be placed into an orbit inclined 58 degrees to the Earth's equator. Orbital period is expected to be 90 minutes, and the satellite's useful lifetime is estimated at two to three months.



NASA ENGINEERS atop gantry finish mating S-6 to Douglas Delta launch vehicle. Satellite is made of stainless steel and weighs 405 lbs. It will be put into Earth orbit at 155 mi. and will make direct measurements of the Earth's upper structure.

If *S-6* is successful it will mark the sixteenth straight success for the *Delta* vehicle, which is managed by the Goddard Space Flight Center.

The two neutral mass spectrometers will count the electrically neutral particles in space by breaking the particles into positive ions and negative electrons. The resulting particles are electrically charged and are made to move through electric and magnetic fields of known strength. The extent to which these particles are deflected by the field depends largely on the mass of the particles, and particles with the same mass will be deflected along the same path.

By placing a sensing device so that it intercepts this stream of particles, the number of particles can be counted. Since the field strength and location of the sensor is specific for certain masses of particles, and since the mass of the ion is specific for each component that is ionized, selected components of the atmosphere can be identified.

Pressure gauges determine the atmospheric pressure by collecting, ionizing, and measuring the neutral particles along the satellite's orbit.

• **Key current**—The electrostatic probes measure the temperatures of electrons and the density of positive ions along the orbit. The individual probe has in it two points of different electrical potential—that is, a voltage difference is maintained across the spaces separating the two points. Since the electrons and ions are charged particles, their passage across the potential gap constitute a flow of electricity, a current that can be measured.

The amount of the current is an indication of the number of particles or density. Other characteristics of this current depend upon the kinetic energy of the particles, and this is an indication of their temperature.

Electrical energy to the spacecraft will be supplied solely by approximately 150 lbs. of silver-zinc chemical batteries. With all instrumentation on, the satellite will consume 110 watts of power; it can operate properly at this load for about 70 hours. Since there is no data storage aboard the spacecraft, and since satellite "turn ons" will last about five minutes, several hundred data passes should be obtained. ■

Senior Technical Men...

YOU'LL FIND A BETTER FUTURE IN SNAP RESEARCH & DEVELOPMENT



The man who knows nuclear-space technology can command his own future.

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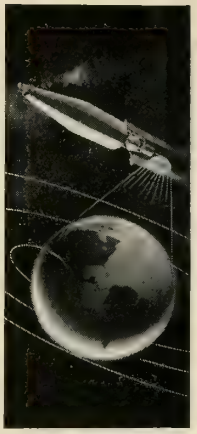
Today at Atomics International, men of imagination are hard at work on SNAP—Systems for Nuclear Auxiliary Power—an Atomic Energy Commission program which joins the technology of the Atomic Age to that of the Space Age. If you are a Senior Scientist or Engineer—if your strength is in analytical, experimental or developmental activity—your talents are needed in this important program. No nuclear experience is necessary.

This is your opportunity to enter at once the two most fascinating technological fields of the foreseeable future. It is your chance to forge ahead with the leading firm in the development of SNAP reactor systems.



Thermoelectric System. First in line among SNAP reactor systems under development at A.I. is SNAP 10A, a 500-watt system which makes use of a thermoelectric converter to transform nuclear heat directly to electric power. The compact reactor, weighing only about 250 pounds, is cooled by liquid sodium-potassium alloy. Zirconium-uranium-hydride material serves as the combined fuel and moderator. The system requires no active control after orbital startup and has no moving parts. Two developmental prototypes have operated successfully for a total of 375,000 kilowatt hours.

Turboelectric Systems. The 3000-watt SNAP 2, another AEC space reactor system being developed by Atomics International, uses the same reactor as SNAP 10A with provision added for active control. Power conversion is accomplished by a unique turbine-generator which operates on a mercury vapor Rankine cycle. All rotating components—turbine, generator and liquid metal pumps—are mounted on a single shaft which rotates at 40,000 r.p.m. A fully-shielded SNAP 2 system weighs only 1350 pounds, yet can supply as much electricity in a year as 250 tons of batteries.



SNAP 8 is a direct outgrowth of SNAP 2 but produces higher output. Atomics International is responsible to AEC for the SNAP 8 reactor-and-shield subsystem, nuclear systems testing and nuclear safety. Using a mercury vapor turbine-generator, SNAP 8 will deliver 30 kilowatts of power—enough to enable orbital tests of ion propulsion engines. The National Aeronautics & Space Administration is developing the power conversion equipment and will accomplish overall system integration.

Opportunities at A.I. Openings exist for those with BS or MS degrees in general engineering; electrical, mechanical or chemical engineering; metallurgy; mathematics; or physics plus three or more years experience. Assignments include heat transfer, thermodynamics, high speed rotating mechanisms, stress analysis, mass transfer, nuclear analysis and component development. If you are interested in making your mark in this important program, Atomics International invites you to inquire for additional information.

Contact: Mr. H. D. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California

ATOMICS INTERNATIONAL

Division of North American Aviation

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Technical Countdown

PROPULSION

Lockheed Licks Solids Restart Problem

Lockheed Propulsion Co. experts have successfully demonstrated immediate and permanent extinction of two 600-lb.-thrust solid motors—both at sea level and at a simulated altitude of 150,000 ft. Four earlier firings resulted in two cases of permanent extinction before total grain burnout. Flame extinction at both pressure levels was achieved without the use of secondary agents and less than a millisecond elapsed between command and shutdown. In every case, portions of the propellant were saved for restart. The company-funded program used LPC's high-energy Polycarbutene propellant containing a high percentage of aluminum. The procedure utilizes the creation of an expansion wave, which causes a sudden and rapid drop in chamber pressure, quenching the flame. LPC chief scientist Leon Green says the way is now open to the development of solid motors with multiple restart and throttling capabilities for upper-stage missions and space vehicles.

Thiokol Steps Up Big Solid Facility Construction

Construction of an inert parts building at Thiokol Chemical's Camden County, Ga., big solid site will begin shortly. The masonry and metal building will be part of the inert parts complex used for storage, preparation and assembly of large component parts for the massive solid units.

Hybrid Rocket Research Contract Let

A new type of hybrid rocket will be studied by Rocket Research Corp. of Seattle under a Navy contract administered by the Naval Ordnance Test Station at China Lake, Calif. Basic research into the combustion of conventional hybrid rockets is included in the effort.

UTC 120-in. Titan Booster Funds Increased

Firm Air Force contracts totalling $175 million have been signed with United Technology Center, division of United Aircraft Corp., for the first stage of the *Titan III-C* launch vehicle. Most of the work on the sets of 120-in solid boosters will be on a cost-plus-incentive-fee basis. The firm also received a design study contract to work on a solid antimissile missile booster rocket capable of acceleration rates from 10 to 100 times greater than "conventional" units—taken to mean *Minuteman, Polaris* and *Scout.*

MATERIALS

Climelt TZC Looks Promising in Sheets

After rolling six new molybdenum-base and tungsten-base alloys into 0.050-in. sheet, Climax Molybdenum Co. is settling on its Climelt TZC (Mo + 1.25% Ti + 0.3% Zr + 0.15%C) as the most promising alloy due to its low density and amenability to heat-induced strength improvements. A second alloy, Climelt WZM (Mo + 25%W + 0.1%Zr + 0.03%C) also exhibited good combinations of strength, recrystallization and transition properties.

Titanium Honeycomb Production Potential

Republic Aviation can now produce titanium honeycomb panels for use in aerospace vehicles. The production potential is the result of a two-year R&D effort with B120VCA titanium and the development of a silver brazing alloy, Braze 951, by Handy & Harmon. The new braze is tailored specifically for improved corrosion resistance. Republic is evaluating three brazing methods—vacuum, graphite-retort and ceramic blanket. The vacuum braze produces a panel superior in appearance to the other two, but the ceramic blanket-inert-atmosphere route provides attractive processing techniques.

Allison Lands Apollo Subcontract

Propellant components for the *Apollo* spacecraft will be built by the Allison Div. of General Motors under contract from North American's Space and Information Systems Division. The contract calls for fabrication of the Service Module's fuel and oxidizer tanks. The sum of the contract is still under negotiation.

ELECTRONICS

Stanford Lets Two Klystron Contracts

The first two production contracts for klystron amplifier tubes to be used in the two-mile linear electron accelerator being built at Stanford University are going to the Electron Tube Div. of RCA, and the Electron Tube Div. of Sperry Rand Corp. Each firm will build 72 tubes. The completed accelerator will contain 240 high-power klystron devices. Though both tubes will have similar operating specifications, the RCA device is reported to be heavier and apparently more expensive. The Sperry contract totals $570,380, while the RCA award is for $730,800. Both contracts contain options for Stanford to purchase up to 180 additional tubes from either. The interchangeable tubes will have peak power outputs of 24 mw, pulse lengths of 2.5 microseconds and repetition rates of 360 per sec., and will use permanent magnet beam focusing techniques.

SPACE MEDICINE

Life Is Where You Find It

Extreme cold and high vacuum may not be severe enough to snuff out certain forms of life. This is the recently reported finding of Soviet Academician Vasiliy Feofilovich Kuprevich, who states that in some instances it is impossible to develop sufficiently low temperatures to kill certain organisms. He observes that the 4 to 5 billion years the Earth has existed is inadequate for the evolution of a number of highly important biochemical processes. Conclusion: spores or other forms of life wandering in space possibly settled on Earth and started the life cycle here.

Microorganisms Unaffected by Zero-G

Weightlessness probably will not have any effect on cellular-level metabolism, says an Air Force scientist. The forces of attraction and diffusion are greater than gravitational forces, since cells continue to react in a normal manner if the body is right-side up, upside down, or in any other position. If enzymatic mechanisms function while the pull of gravity varies ±1g., it is difficult to imagine that zero-g could affect their operation, says Dr. Dale Clark of USAF School of Aerospace Medicine.

Trainer To Simulate Gemini Mission

Special digital computer designed and built by Link will be wired to modified capsule for crew instruction

by William Beller

THE FIRST U.S. space trainer developed specifically to simulate a complete mission—from pre-launch through re-entry and letdown—has been designed for *Gemini* astronauts. It will be installed later this year at NASA's Manned Spacecraft Center, Houston, and at Cape Canaveral.

The equipment also will be used to check out tests and procedures. It may help tell, for instance, whether the rendezvous-and-docking maneuver as it is now set up will be easily controlled by the astronaut. Telemetry data produced by the trainer may be used to school ground crews at NASA facilities.

The trainer, in effect, will be testing control-panel apparatus and procedures as well as men. It will thus become a proving tool for new techniques and systems for future manned spacecraft.

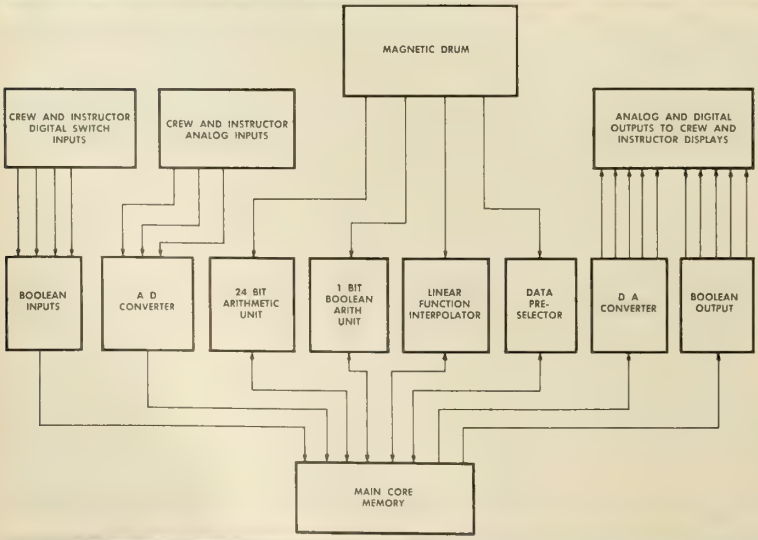
● **Real-time digital computations**—The *Gemini* mission—plus abort and emergency conditions—will be simulated through a special-purpose digital computer designed and built by Link Div., Simulation and Control Group, General Precision, Inc., under subcontract to McDonnell Aircraft Corp., *Gemini* prime contractor.

Called the Mark I, the new computer will provide simulation computations—in real time—for pre-launch, launch, insertion into orbit, orbit, rendezvous and docking, retro-fire, reentry and letdown. For crew training, the computer will be wired directly into a modified *Gemini* capsule.

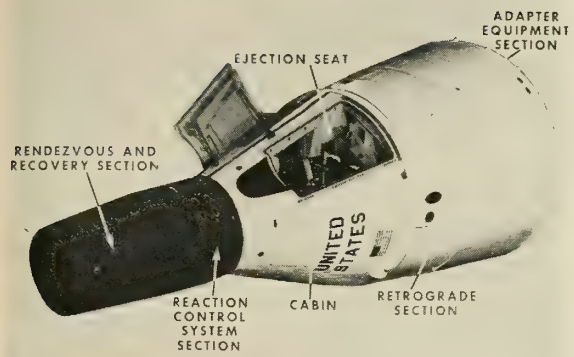
The Mark I reportedly will be the first U.S. operational simulator-computer that is all-digital—a distinct advantage when flight variables are changed. Developed by Link in 1960, it was built solely for dynamic simulation of complex aircraft and for space-training applications. For this reason, the company claims, the computer "is substantially less expensive and will be much easier to program than any commercially available computer would be in this application."

One evidence of acceptance is that the computer is being incorporated into Link's all-digital Boeing 727 simulators, to be installed at Eastern Air Lines and United Air Lines facilities. Air Force C-135 simulators also will use Mark I's.

A similar computer will be installed



BLOCK DIAGRAM of Link Mark I special-purpose digital computer showing parallel operations. Boolean inputs: *one-binary-bit inputs used to monitor switch positions in the capsule.* Analog-to-digital converter: *converts an analog-voltage (d-c) to a corresponding binary code, which is loaded into a preassigned core location.* 24-bit arithmetic unit: *performs all arithmetic computations.* Boolean arithmetic unit: *performs all single function operations such as AND, OR, STORE, etc.* Linear function interpolator: *data-storage device. It stores nine discrete points of a function of X, for example. If a desired point falls between two discrete points, the LFI determines its X and Y values through linear interpolation.* D/A converter: *converts a binary number to its corresponding dc voltage.* Boolean output: *merely an "on" or "off" signal, such as to a relay.*



MODIFIED GEMINI capsule to be used for crew training.

in mid-1964 at Edwards AFB, Calif., for spaceflight simulation work in connection with the aerospace research pilot school.

For the *Gemini* mission, the Mark I will obtain simultaneous, real-time solutions to the equations describing orbit mechanics, aerodynamic forces, and trajectories during simulated launch, orbit and descent. Other factors entering into the computations: equations of motion, guidance functions of the "onboard" computer, attitude control and all other functions associated with the flight of the spacecraft. Orbit mechanics and attitude control of the target vehicle for the rendezvous maneuver will also be computed in the Mark I.

● **Astronaut in the capsule**—Asked for a typical example of astronaut training on the mission simulator, G. G. Abbey, *Gemini* project manager at Link, suggested instruction in manual attitude control. "The attitude of the simulated craft is continuously computed by the Mark I," he told MISSILES AND ROCKETS, "and displayed to the crew on the attitude gyro.

"The astronaut may command an attitude change by actuation of his hand controller. This command is inserted into the computer via a digital switch input or an analog input. The magnitude or duration of the input signal is used to compute a resulting thrust, which in turn modifies the moment computation, the fuel and oxidizer quantity, spacecraft weight-and-balance and other quantities."

As a result, he said, "the effect of a change in the computed moment will be displayed to the crew via an analog output from the Mark I to the attitude gyro."

● **A split memory**—The Mark I meets the varied dynamic requirements of *Gemini* simulation problem by dividing the mission computations into two distinct groups, which are stored on the general program section of the Mark I drum. The first group—for the slower-moving varibles—includes the pre-launch, boost, insertion, orbit, rendezvous and docking computations.

The second group includes aerodynamic reentry and letdown computations, many of which require iteration frequencies of 20 cps. Switching between the two programs will take place automatically—in 0.025 sec.—when retro-fire time is reached, abort is initiated, or switching is activated by the instructor.

A section of the Mark I drum, designated the automatic-data-preselection-band—used for radio facility simulation in aircraft flight simulators—will serve in the *Gemini* flight-trainer computer as a storehouse of initial conditions. The instructor may introduce them on command, thereby providing an automatic problem-reset capability.

● **Varied initial conditions**—The company states that there are 32 sets of initial conditions in the preselection band. When a particular set is selected, the words of that set will be loaded into preassigned core-memory locations for computational use. In addition, a 33rd set-of-words location is available. It can be loaded by the instructor at any point during the mission so he may return to it. In this way, he can meet various training needs.

The instructor also has the option to advance or retreat from the present phase of the mission. He can skip a particular portion of the mission or rerun the same mission phase over and over again. This enables him to save time, for example, by going from launch directly to the retro-fire phase.

When an instructor wants to start a training exercise, he switches to one of the 32 sets of initial conditions. This is done by pushing an "enabling" button that inserts the conditions into the time-varying equations. When the "operate" button is pressed, the problem begins to unfold.

If the instructor wants to jump ahead to a new phase during the operation, he pushes a problem "freeze" button. He then selects the new phases desired, pushes the "enabling" button, and resumes the exercise by pushing the "operate" button.

● **Advantages over analog**—The Link Mark I input-output system operates automatically. The company says no instructions are required to accomplish the input/output memory transfers, or conversions, to or from digital form; and consequently there is no reduction in the time available for execution of the general program.

The input system automatically scans analog inputs from the crew and instructor, converts them to digital form, and loads them into pre-assigned core-memory locations. The output system similarly obtains variables from preassigned core-memory locations, converts them to analog quantities, and makes them available on separate output lines for use outside the computer.

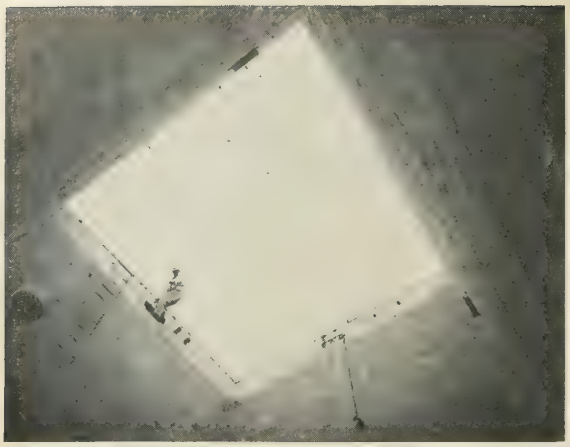
Because the Mark I program is changed infrequently—in contrast to most programs for scientific computer application—it can be stored more or less permanently on a magnetic storage drum. Link says a time penalty is paid in a conventional digital computer because it must wait after the execution of each instruction for the next instruction to be obtained from the core memory.

On the other hand, Link points out, the Mark I does not pause between instructions: they are stored on the drum in the exact order they are performed. While one instruction is being performed by the arithmetic element, the next one is moving into position to be read. Most instructions require only one access to the core; others require none.

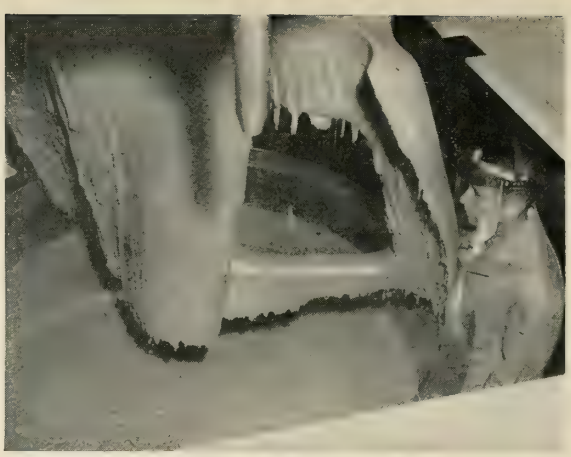
Until recently, flight simulators were based almost exclusively on analog computational techniques. A big problem in certain applications of analog simulators is that the organization of the computing elements of these machines must be very similar to the organization of the mathematical equations describing the operational system. This means that for every element in an equation there must be a corresponding element in the computer which, as a rule, serves only this one function. Thus as the complexity of the equations increases, the complexity of the analog hardware also increases.

On the basis of this reasoning, Link claims, "digital computers, employing basic on-off decision elements with broad safety margins, present less demanding requirements with regard to power-supply regulation, freedom from noise, and mechanical wear." In addition, "the problem of program setup and verification of operation of the computer before a program runs are extremely small in comparison to those in an analog simulator."

Furthermore, Link says, "digital computers provide the large volume of required operations, both linear and non-linear, for extreme fidelity in spaceflight simulation." ■



ONE OF TWO huge new cast-cure pits at McGregor. Each can handle four Minuteman first-stage size motors at one time.



NEW 300-gal. mixer runs through shakedown period with inert fuel. Unit can process 4500 lbs. in single batch.

propulsion engineering

McGregor Plant Boosts Its Capacity

Rocketdyne plans to add new facility that will enable it to handle 3-million-lb.-thrust solid engines

by John F. Judge

McGregor, Tex.—The second phase of a $2.3-million construction program will soon be under way at Air Force Plant 66, a solid-rocket facility operated by the Rocketdyne Division of North American Aviation.

When completed, the additional production capacity will total more than 12 million lbs. of high-energy castable solid propellant per year.

In addition, plans call for building a control center and test stand capable of handling solid engines with thrusts up to three million pounds. Such motors would weigh around 250,000 lbs. and be 13 ft. in diameter. The facility will put Rocketdyne's McGregor installation in the running for future large solid development work.

The huge stand will be capable of holding motors in either a vertical or horizontal position during test firings. The reinforced concrete walls will range in thickness up to 10 ft. and rest on a 12-ft.-deep foundation of solid concrete. The stand has been designed for the eventual addition of two 15-ton capacity cranes. The installation will be McGregor's seventh test stand. Four 15,000-lb., one 85,000-lb. and one million-pound facility are already in operation.

The control-center will evolve from an existing structure and will house an advanced high-speed data-acquisition system. The muti-channel, high-response system will be used during tests to gather information on thrust, pressures, temperatures and strains.

● **First phase ending**—The first phase of the construction job—building of two huge casting and curing pits, two propellant mix buildings and a non-destructive test facility—will soon be completed.

The two pits each measure 20 ft. square by 35 ft. deep, providing manufacturing space for motors up to 160-in.-dia. A 300- and a 250-gal. pair of mixers has been installed in the mix buildings. The x-ray equipment includes a 13-million-volt machine capable of penetrating 100 inches of propellant, with an exposure time of approximately 105 min.

About 60 in. of propellant can be penetrated in 2.5-min. exposure time. The present 400,000-volt unit at McGregor can penetrate a maximum of 12 in. of propellant with six minute's exposure.

The solid rocket operation is undergoing a planned, incremental expansion—program by program. Even the huge casting pits under construction are planned to be useful for smaller motors. Each pit can handle a 160-in.-dia. motor or four units of varying sizes. These latter can range up to the size of a *Minuteman* first stage.

All four could be in a pit simultaneously, yet be undergoing different stages of manufacture. One could be undergoing case preparation, another could be in cast, the third curing and the fourth cooling. There are four air blowers in each pit for cooling.

These blowers will carry hot air for curing or ambient-temperature air for cooling after cure. The pits are designed for future installation of cooling coils and compressors to permit temperature cycling of finished motors.

● **Future planning incorporated**—The construction effort fits into the Rocketdyne development plan—an approach to future solids areas on a program-by-program basis. There is no immediate intention to begin work on the large solid booster.

The division manufactures the new



MAIN casting bell is shown during removal of a Teflon-coated mandrel.



ADVANCED booster powers Army's Redhead-Roadrunner target missile.



SOLID propellant gas generator is welded with propellant inside.

propulsive unit for the *Sparrow III* missile, which combines a free-standing propellant charge with an improved propellant resulting in a substantial increase in performance and operating temperatures.

The booster for the Army's *Redhead-Roadrunner* target missile is produced at McGregor, as are the Megaboom sled boosters for the track at Holloman AFB, N.M.

Another profitable product line covers a series of solid propellant gas generators—used in operational missiles such as the Navy's *Tartar* and *Terrier* systems. One generator design supplies the power to start the fuel and oxidizer turbopumps on the *Saturn I*.

In service, each of these turbine starters supplies 1500 horsepower for one second. Other units are used on the advanced *Atlas*. In designing the starter assemblies, the Solid Rocket Division developed a welding technique that permits metal joining after the propellant charge has been inserted.

The welding technique resulted in considerable weight savings over the former method, which involved a screw-on head with an O-ring seal.

The solid gas charge is extruded ammonium nitrate—with an autoignition temperature of 400° F if held for five minutes. Thus the welding setup is remotely controlled.

● **Thermal Blockage**—The first problem encountered in the solid-propellant gas generators was that of perfecting a heat-sink ring for the area behind the lap-joint weld to insure the least effect from annealing in the heat-affected zone. The most successful type had a tapered cross-section providing a low mass opposite the weld, increasing to a relatively high mass aft of the weld.

The next problem involved cooling the propellant. McGregor specialists accomplished this by placing a chill bar around the case aft of the weld. The chill bar is a copper ring containing water-cooling passages. With this arrangement, the propellant reaches a maximum of only 130°F five minutes after concluding the weld cycle.

A reinforced-concrete wall shields the operator from the welding rig in the event of an accidental ignition. Before making the weld, the operator moves his remote console into the welding cell for setting up and alignment.

Once this is done, he moves the console out of the cell and into position for welding. A safety interlock located outside the cell eliminates the possibility of creating an arc while the console is in the cell.

● **Welding details**—The welding equipment is designed to operate on a double cycle. A short (3-to-7-second) first cycle establishes the arc and allows final checking for the proper conditions. The second cycle—welding—follows immediately.

At the start of the first cycle, a variable-speed drive rotates the workpiece, the welding head descends, coolant flow commences and the arc is established at 30 amps. To set the arc length, the operator adjusts the voltage to a predetermined amount with a micrometer voltage adjustment.

The second cycle starts when the operator energizes another circuit. Another motor-driven rheostat increases the amperage to the level required by adding the filler metal. As this preset amperage is reached, the weld wire advances automatically into the puddle at a precise rate.

At this instant, the operator starts timing the procedure with a stop watch. As the operation continues, he keeps an eye on the voltage and amperage and corrects any deviations. He also resets the first rheostat to its starting value of 30 amps. If this is not done it would prevent tapering off the amperage at the end of the weld—causing excessive heat and possible burn-through.

When the operation has run for exactly three minutes (± 5 sec.) the operator pushes the stop button. The wire feed stops and the current drops to a pre-set taper-off amperage. A timed decay of weld-heat begins.

The decay slopes down to 30 amps, and the unit cuts off the arc and ceases rotation. A cooling period of five minutes elapses before any one enters the welding cell. The total floor-to-floor time is 15 min.

In addition to cutting weight, the welded generator case eliminates the leak possibilities always present with the screw-on type. The manufacturing procedure is easier and more economical with the weld technique. The units have been test-fired and then subjected to hydrostatic pressures up to 6400 psi without bursting. Operating pressure is in the neighborhood of 3500 psi.

● **Tartar, Terrier typical**—The engineering problems associated with the design of solid gas generators are best illustrated in the MK-2 and MK-3 units—the *Tartar-Terrier* power sources.

These were to be twin units, one to power the electrical system, the other to provide a pressure head to the hydraulic system. The two generators were to be used interchangeably on the two missiles, which have completely different ranges and performance characteristics.

The major problem at the time was to precisely tailor the propellant package to fit all the performance requirements. The same propellant had to produce the burst of starting power, to overcome turbine wheel inertia and also generate a slower-burning, longer-duration gas stream to maintain speed. ■

Field Facility Speeds Tests of Atlas Silo Struts

A SPECIAL field production facility has been set up to speed testing of components of the giant shock struts in the *Atlas* ICBM underground silo support system.

The facility is operated by AMF Beaird, Inc., an American Machine & Foundry subsidiary, and the Materials Testing Lab division of Magnaflux Corp. It has reduced test time from hours to minutes, yet held to rigid specifications set by the Air Force.

At the AMF Beaird plant in Shreveport, La., thousands of ultra-high-strength steel components in all sizes and shapes—including rods up to 20 ft. long—were carefully and thoroughly put through a variety of nondestructive tests to insure 100% performance under nuclear blast conditions.

AMF is subcontractor to General Dynamics/Astronautics for design and manufacture of the entire silo-support and missile-lifting system for the *Atlas* ICBM network.

Each 250,000-lb. *Atlas*, tucked neatly in a 180-ft.-deep, 60-ft.-dia. underground silo, is supported and raised for firing by a 150-ft.-high structural steel framework. The total unit—called a crib—is equal in mass to a 15-story steel-framed building and weighs approximately 3,000,000 lbs.

● **Shock system**—This entire crib is suspended within the silo by four pairs of 40-ft.-long spring shock struts secured to the concrete silo walls.

Shock strut assemblies are composed of six or seven sets of three concentrically positioned expansion springs. The typical outer springs are approximately two feet in diameter and formed of 3½-in.-dia. alloy steel wire.

Spring capsules are separated by spring seats and spacer plates; the total unit is held together by four vertical rods composed of shorter coupled sections of 2½-in. and 5-in.-dia. high-strength steel sections.

Principal purpose of the eight shock struts is to provide vertical and horizontal isolation for the crib, missile, and ground-support equipment through spring and pendulum action.

For each strut, a total of 46 separate components had to be tested, including 10 rods of various lengths and diameters, one spreader plate, seven circular spring seats, seven triangular spring retainers, three spacers, five couplings, and 16 lock nuts.

Though the actual number of individual parts to be tested under the total program is undisclosed, it is estimated that more than 45,000 components had to be internally and externally examined within the six months allowed for the program.

● **Round the clock**—In an unorthodox departure from normal procedure, Magnaflux set up a full-scale, completely equipped laboratory in the field and detached 13 engineers and technicians from MTL labs around the U.S. to go to work immediately with 26 AMF inspectors in round-the-clock shifts.

To house the test facility, AMF erected a 10,000-sq.-ft. building, designed and built all material-handling equipment, including a unique overhead "merry-go 'round" that cut materials in one operation by 75%.

Nine pieces of sensitive, high-speed magnetic particle and ultrasonic equipment were also rushed to Shreveport, including Magnaflux's newly developed pulse ultrasonic PS-800 instruments.

The lab was laid out in two production testing lines—one to handle the long-length cylindrical rod; the other to handle the specially shaped spreader plates, spring retainers and seats, lock nuts and couplings.

Rigid contractor specifications for acceptance standards on the rods labeled four unallowable surface defects: fatigue cracks, heat-treat cracks, burst and internal rupture, and grinding and/or thermal cracks.

Laps and seams more than 20 degrees from the long axis of the part were not allowed, nor was removal acceptable in threaded areas or thread reliefs. Such defects made the part acceptable if the flaw was removed by grinding and smoothing to a maximum depth of no greater than 3/32 in. in 5-in.-dia. rods, and 1/16 in. deep in the 2.25-in.-dia. rod.

There are many such particulars called out, but rods containing defects in excess of five in any one foot of rod length, or more than an average of two per foot of rod, would be rejected.

Procedure for testing shock strut rods begins with thorough cleaning of the rod surface to insure that no paint, grease, rust, scale, dirt or other foreign matter will interfere with accurate interpretation of the test.

● **Magnaglo procedure**—In the Magnaflux magnetic-particle method, a magnetic field is electrically induced into the rod, which is then sprayed with a suspension fluid containing fluorescent coated particles of iron oxide. Where microscopic flaws exist on or near the surface, a north and south pole condition is created, which attracts the iron oxide particles.

When viewed under a high-intensity black light, the formation of particles clearly defines any flaws. This test is conducted in an area darkened by a hood enclosure.

The complete magnetic-particle inspection of one rod was completed in about 10 min., with a maximum of 120 rods per day moving through the Shreveport test facility.

After magnetic particle inspection, rods were moved to the next station where high-frequency sound waves from the Magnaflux PS-800 instrument searched for internal flaws. ■



LONGITUDINAL magnetic field is induced into rods to detect transverse discontinuities, with concurrent application of the Magnaglo bath.

Lockheed Refines Jet Tab Technique

Firm draws on Polaris A3 experience, finds tab approach promising for big-solid thrust-vectoring

by Russell Hawkes

LOCKHEED AIRCRAFT CORP. reports that jet tab thrust-vectoring may prove to be of key importance in the Air Force's large solid-propellant motor program.

Lockheed Missile and Space Co., which initially developed a *Polaris* jet tab, says it appears to have some distinct advantages over other thrust-vectoring devices in very large motors.

The jet tab approach is one of four development packages to be divided among major solid-rocket companies in the AF program. LMSC is not competing in the program, but is giving technical support to its corporate sister, Lockheed Propulsion Co. If LPC gets the jet tab package, LMSC will seek a subcontract to do some of the development.

The four packages in the large solid program include:

—The jet tab.

—A swivelled nozzle made of a new maraging steel (martensitic, high-nickel alloy).

—Study of the feasibility of a 260-in-dia. motor.

—Development of a 156-in.-dia., five-segment motor for research on nozzles for the 260-in. motor.

● **Genesis**—The jet tab was proposed by Lockheed for the thrust-vectoring job on Navy's *Polaris A3*, but the propulsion contractors, Aerojet-General Corp. and Allegany Ballistic Laboratories, chose to use rotating nozzles and secondary fluid injection, with which they were more familiar. LMSC scientist Willi Fiedler did the early work on the jet tab because of limitations on the usefulness of jetavator controls used in earlier *Polaris* versions and developed by Fiedler when he worked for the Navy at Pt. Mugu.

Most of the LMSC jet tab development was paid for by the Navy and is widely available to the industry and other services. A total of 70 copies of the project report have been sent out by *LMSC* on requests relayed by the Navy.

Fiedler is quick to point out that thrust deflection by obstacles inserted in the exhaust jet is by no means new. Patents on such controls date back to Dr. Robert Goddard, the founder of modern rocketry. The French also have developed an oscillating jet tab for a small rocket.

Fiedler also observes that there is no such thing as a single best thrust-vectoring system, and any selection should always be a process of optimization for the individual design being considered. An external factor is, of course, the experience of the company doing the development work. Lockheed engineers say any of the current thrust-vectoring systems can be made to function satisfactorily if enough time and money are expended in the development effort. If there are fixed ceilings on these, a propulsion company will get the best performance from a system with which it is familiar—hence Lockheed's interest in showing its experience with jet tabs.

Fiedler began company-funded work on the jet tab in 1959, when rising flame temperatures of solid propellants began to require that jet deflecting devices provide a considerable mass of metal to act as heat sink.

The smaller exposed area of a jet tab results in a smaller heat sink requirement. If the total heat input is small enough, the optimum jet tab design begins to approach the dimensions of a jetavator because of a given thrust deflection tends to require a smaller thrust degradation if the intruding tab has a low aspect ratio—that is, a shallow pentration along a wide segment of the exhaust cone.

● **Akin to jetavator**—Fiedler regards the tab as a natural progression from the jetavator. A jetavator provides two-thirds of its control force by the impact of the exhaust jet on the jetavator ring as one edge of it is rotated into the flow from the motor. One third of the control force is exerted on the nozzle expansion cone by an oblique shock wave generated at the leading edge of the part of the flow retarded by the jetavator ring.

Tabs act entirely by the force of the oblique shock upon one side of the expansion cone.

Being perpendicular to the direction of flow, the tab produces a strong vortex on its upstream side, and the oblique shock is generated higher in the expansion cone for the area exposed to heating. As the tab is extended further into the flow, the shock moves further into the nozzle and affects a larger area on its wall. If this were carried too far, the thrust degradation would become unacceptable and the oblique shock might even touch the other side of the nozzle, producing a reverse control force.

Zero position for the tab is with its edge just penetrating the low-energy boundary layer coming from the nozzle exit so that the response to guidance commands is immediate and linear.

When the initial LMSC development of the jet tab ended in 1961, Aerojet continued to work on the technique and has recently tested semicircular tabs in a static firing of a large motor. Fiedler says that the selection of tab shape should be dependent upon the total heat input from ignition until burnout.

● **Relative merits**—A major factor other than flame temperature is the total duration of exposure to the direct blast of the motor and the area exposed. If the complex guidance programs or a highly unstable vehicle calls for frequent or extreme control forces, the tabs show definite advantages over secondary fluid-injection thrust-vectoring and jetavators; the weight of stored thrust-vectoring fluid in the former and the weight of heat sink material in the latter become excessive.

For very large motors, rotating and swiveling nozzles have the disadvantage of large mass, which must be moved around by control system actuators. Tabs have an advantage in program management, since the control system can be developed separately and bolted on later without ever being a complicating factor in the design of the engine itself.

Lockheed-made jet tabs have been sandwich structures with a high-temperature-resistant face, a heat-sink core, load-bearing back-up structure, and thermal insulating fairing to block heat inputs from the flame downstream. Fiedler says in very large systems it might be profitable to replace the heat sink with a closed-loop coolant system. ■

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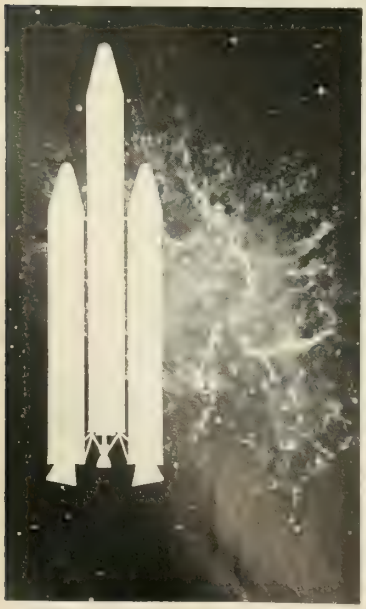
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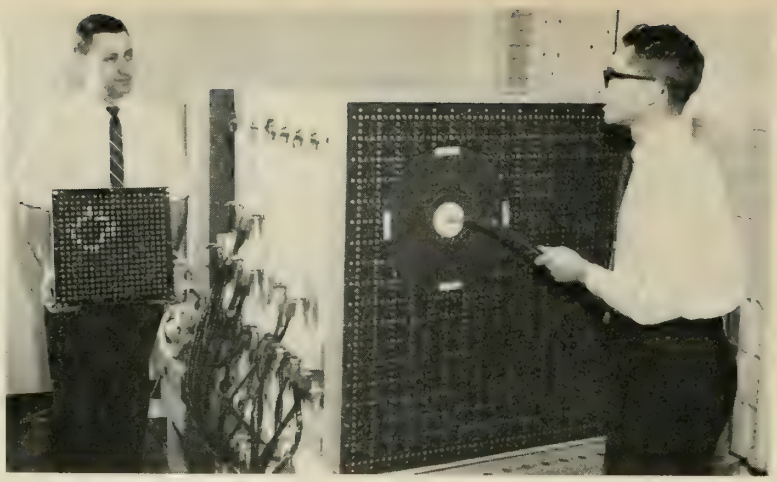
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RCA machine shows what frog's brain (left) receives from frog's retina.

bionics

Symposium Points to More AF Emphasis on Hardware

by Heather M. David

DAYTON—The importance of bionics—perhaps the newest science—to the missile/space industry was underscored here at an Air Force-sponsored symposium.

Trends at the meeting indicated that the Air Force will put increasing emphasis on bionics-developed hardware. The value of these systems, said Air Force Maj. Gen. Theodore Bedwell, is their remarkable economy, precision and effectiveness.

Bionics, as defined by members of the Air Force's Aeronautical Systems Division, is the science or technology devoted to the study and analysis of living systems and the physical realization of the more sophisticated functions of these systems.

Generally, there are two types of, or approaches to, bionics—"bloody" or medical bionics, and engineering bionics. Medical bionics is primarily concerned with examining, dissecting and otherwise studying biological systems to understand them better. The engineering-oriented bionics tries to create machines which will duplicate biological functions.

Both work together to develop new electronic and electrochemical machines.

● **New systems**—Here are some of the developments described at the conference:

—Electronic data processing systems may be produced by Radio Corp. of America laboratories based on the way a frog processes visual information. RCA based its idea on a Massachusetts Institute of Technology study of the frog's retina.

The MIT investigators placed tiny metal electrodes, through surgery, on fibers in the neural trunkline leading from the optic nerve to the brain. They found that some data were screened out by the frog's retina, and that selected information which reached the brain was limited to four kinds of fibers in this nerve trunkline. This information consisted of: moving convexities, contrast or edge detection, motion, and dimming.

RCA Labs at Princeton, N.J., then devised and constructed a pattern recognition machine which operated along these lines.

—A method may be developed to make it possible for guidance and con-

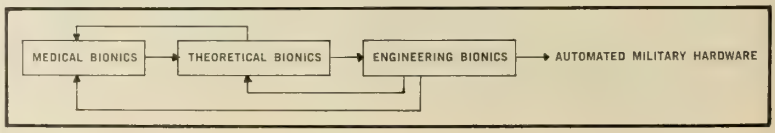


CHART SHOWS how military hardware evolves from studies in bionics.

trol systems to sense partial failures and correct themselves in the same manner that living organisms sense pain and initiate a self-healing process. According to Nortronics Div.—Northrop Corp. engineers, these techniques can be applied to complex electronic or electromechanical systems, which—rather than cease operating with a partial failure—carry out their functions improperly.

—Techniques are being worked out for advanced engineering control systems through study, or servoanalysis, of the leg muscles of the cat. Aerospace Medical Research Lab scientists pointed out that the cat's leg is an example of how biological systems seem to use two unidirectional control systems, rather than the single bidirectional systems designed in machines. While biological systems tend to be non-linear and have a great deal of mechanical resistance, they work intriguingly well and are able to control under varying loads.

—Bionics may solve the problem of erratic stresses in hydraulic systems which have caused many aircraft accidents, and loss of efficiency in fuel consumption and power production of missiles. Dr. Harry Lobel of the Brownell Hall-Talbot School applied a principle of electrical analogs to arterial pulsations and an anatomical discovery in the arterial system. He pointed out that arterial nozzles have neuromuscular controls which change the contour to correspond with varying flow conditions—a technique which might be used in design of aeronautical and submarine hydraulic systems.

—Man's performance, especially that of a space pilot, can be improved by myoelectric servo control. Spacelabs Inc., under an ASD contract, developed a system which could enable a subject to move his arm to certain positions in a space capsule under heavy g loads.

—Melpar, Inc., has built a large artificial nerve network (LANNET) for the Air Force. This system, which contains 1024 statistical switches, or 250 artificial neurons, will be used to study how biological systems handle information. These will include maze-learning, Pavlov-conditioned response, perception and mechanical effector control.

The Air Force also announced that by this fall it would have a new facility at ASD for the study of bionics, which will eventually have 80 scientists and technicians. Aerospace Medical Research Labs and Aeronautical Systems Division personnel at Wright-Patterson AFB will be assigned to the new unit the Air Force said.

Nearly a thousand industry and university representatives attended the conference and heard 70 papers. ■



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Trade Secrets Case Appealed

The B. F. Goodrich Company has appealed to a higher court in a case regarding disclosure of trade secrets to another firm.

Goodrich had sought an Ohio court order restraining a former employee from working in the space suit department of International Latex Corp., and from disclosing Goodrich's confidential information to his new employer—but the court ruled in favor of the employee. An Ohio Court of Appeals will hear oral arguments on the merits of the case before the end of this month.

Signed, Sold, Merged

The directors of Allied Research Associates, Inc., and the board of Baird-Atomic, Inc., approved at separate meetings consolidation of the two companies into a new firm, Baird-Allied, Inc. Terms of the merger call for the new company to begin operations on May 1. Stock will be exchanged in the merger transaction. . . . *Now awaiting approval by stockholders is the merger of General Controls Co. into the International Telephone and Telegraph Corp. Stockholders of both firms are expected to act on the merger within the next two weeks.* . . . The year-old Micro-Radionics, Inc., producer of microwave components and GSE test gear, has acquired Remanco, Inc., Santa Monica, Calif., maker of simulation instruments. MRI was a product of the 1962 sale of the Kearfott Microwave Div. Remanco's operations will be integrated into MRI's Van Nuys, Calif., facility, and its line will continue to be produced under the Remanco name. . . . *H. O. Boehme Co., Inc., gyroscope and instrumentation manufacturer, has been acquired by Packo Companies, Inc, a diversified management company. The acquisition followed on the heels of an announcement that Boehme had, in turn, acquired Spirotech, Inc., a manufacturer of precision potentiometers. Details of the two transactions were not disclosed.* . . . Beckman Instruments, Inc., has decided to give up panel meter component manufacture. Simpson Electric Co., Chicago, will take over Beckman's line in this field. . . . *Teleflex Inc., Pennsylvania manufacturer of remote-control systems, has acquired Ongaro Dynamic Industries, Inc., Columbus, Ohio, tachometer-flowmeter producer. Ongaro's production facilities will be moved to North Wales, Pa., according to provisions of the merger.*

AIA Publishes Magazine

The Aerospace Industries Assn. has issued the first edition of its magazine, *Aerospace*. To be published quarterly, the magazine constitutes the core of a service to editors and organizations, in that all articles may be quoted or reprinted, and the illustrations appearing in the publication are made available without cost.

The first issue of *Aerospace* opens with an article by NASA Administrator James E. Webb, discussing the role of the industry in space exploration and the importance of the space effort to national security.

Industry Facilities

Hercules Powder Co. will build a new nitrogen tetroxide manufacturing unit at its Hercules, Calif., plant. The unit will be a duplicate of the one already at the California site, which has been in operation for four years. . . . *Control Data Corp. will establish a new computing facility as part of the machine simulation and research activity of the firm's System Sciences Div. To be housed in the Los Angeles headquarters building of the division, the facility will be used exclusively in executing research and analysis projects of the division.* . . . Construction will begin during the second quarter of this year on an inert parts building on the site of Thiokol Chemical Corp.'s space booster plant in Camden County, Ga. This construction is in addition to plans announced last month to build a 120-ft.-deep, 50-ft.-dia. casting, curing and testing pit designed to handle motors generating 12 million pounds of thrust. . . . *United Technology Center has opened a new office at the Martin Company's facility near Denver. The office will serve in the coordination of the two firms' activities related to the AF Titan III space vehicle program. UTC is a division of United Aircraft Corp.* . . . Elmwood Sensors, Inc., has moved its entire manufacturing facilities from Providence to Cranston, R. I. The new facility covers 12,000 sq. ft. Elmwood manufactures miniature precision thermostats. . . . *Union Carbide Corp.'s Linde Co. has opened a Huntsville, Ala., office. The new office will be responsible for coordinating the activities of Linde's Cryogenic Products Dept. with NASA and with aerospace contractors throughout the Southeast.* . . . Royal Research Corp., subsidiary of Royal Industries, Pasadena, Calif., has moved into a new 25,000-sq.-ft. facility near San Francisco. The $400,000 plant provides twice the space available in Dublin, Calif., facilities originally leased by the firm. Royal Research manufactures vacuum gear for environmental testing and is engaged in nuclear research and development. . . . *F. J. Stokes Corp. will build a supplementary plant in Bucks County, Pa. The 68-year-old firm's line includes small precision-casting furnaces, space-environment-simulation systems and impregnating equipment for electrical components.* . . . The Armour Research Foundation of the Illinois Institute of Technology has established a new space sciences center at Chicago. Called the Astro Sciences Center (ASC), the new facility will handle ARF's research projects for NASA. ARF plans to change its name to IIT Research Institute on June 1. ASC will be headed by Dr. Leonard Reiffel, ARF's director of physics research.

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AWARDS

AIR FORCE

$17,900,000—**Martin Marietta Corp.,** Denver, for *Titan II* missile production. Work to be done at Littleton, Colo.

$11,000,000—**Boeing Co.,** Seattle, for continued work on the *Dyna-Soar (X-20)* spacecraft.

$8,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for work on liquid rocket engines.

$7,400,000—**Rand Corp.,** Santa Monica, Calif., for continued aerospace research.

$5,300,000—**Radio Corp. of America,** New York City, for continued operation, maintenance and logistic support of "White Alice" communications system at Anchorage, Alaska.

$5,200,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for *Minuteman* first-stage rocket motors.

$4,800,000—**Hughes Aircraft Co.,** Culver City, Calif., for research and development on the fire control system of the *Falcon* missile.

$2,700,000—**Continental Aviation & Engineering Corp.,** Detroit, for classified work on various projects.

$2,000,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for modification of *Thor* booster, launch pad, launch control facilities and related work.

$1,700,000—**Radio Corp. of America,** New York City, for modification and equipment maintenance of early warning sites in Alaska.

$1,400,000—**Martin Marietta Corp.,** Denver, for *Titan II* technical manuals, and communications-reproduction systems.

$1,400,000—**General Precision, Inc.,** Little Falls, N.J., for development of a hydrogyro guidance system.

$1,400,000—**General Dynamics Corp.,** San Diego, for work on the *Atlas* ICBM.

$1,115,943—**Aircraft Tools, Inc.,** Los Angeles, for provision of engineering data, model specifications and technical instructions for *Minuteman* missile site cable splice case assemblies.

ARMY

$9,300,000—**General Electric Co.,** Syracuse, N.Y., for *Nike-Hercules* high-powered radar.

$3,675,120—**C. H. Lavell & Co.,** El Paso, Tex., for erection of radar equipment at White Sands, N.M., missile range.

$2,600,000—**Western Electric Co.,** New York City, for *Nike-Hercules* modification kits. Work to be done at Burlington, N.H.

$2,100,000—**Hayes International Corp.,** Birmingham, Ala., for *Pershing* missile trainers.

$1,967,120—**Martin/Orlando,** Orlando, Fla., for a program definition study and system design for a new communications system.

$293,000—**Schaevitz Engineering,** Pennsauken, N.J., for missile carts.

$62,500—**Western Electric Co.,** New York City, for *Nike-Hercules* missile repair parts.

NAVY

$6,100,000—**North American Aviation, Inc.'s Rocketdyne Div.,** Canoga Park, Calif., for early production of solid-propellant motor of *Sparrow III* missile. Work to be done at McGregor, Tex.

$4,405,760—**Sperry Rand Corp., UNIVAC Div.,** St. Paul, Minn., for development of an advanced computer; design, development and fabrication of digital weapons designation and direction equipment; and research on utilization of smaller thin-film packages for faster processing of information (3 contracts).

$2,400,000—**Hercules Powder Co.,** Cumberland, Md., for continued research and development on solid propellants.

$1,600,000—**Litton Systems, Inc.,** Woodland Hills, Calif., for overhaul of inertial navigational systems.

$1,500,000—**Model Engineering and Manufacturing Corp.,** Huntington, Ind., for production of missile and torpedo gyroscopes.

$1,300,000—**Lockheed Aircraft Corp.,** Bacchus, Utah, for *Polaris* IRBM second-stage motors.

$1,300,000—**Raytheon Corp.,** Lexington, Mass., for production of *Polaris* missile fire control systems.

$1,200,000—**Avco Corp.,** New York City, for *Polaris* missile arming and fusing devices. Work to be done at Evendale, Ohio.

$44,000—**North American Aviation's Autonetics Div.,** Anaheim, Calif., for a sonar signal analysis study.

NASA

$9,400,000—**Paul Hardemann Co.,** Los Angeles, for construction of two static-test towers for the *Saturn S-IVB* stage.

$5,904,254—**Lear Siegler, Inc.'s Electronics Instrumentation Div.,** Anaheim, Calif., for work with instrumentation systems at the Marshall Space Flight Center test division at Huntsville, Ala.

$3,400,000—**Greenhut Construction Co.,** for construction of a dynamic test facility at the Marshall Space Flight Center, Huntsville, Ala.

$3,000,000—**Minneapolis-Honeywell Regulator Co.'s Aeronautical Div.,** Minneapolis, for continued work on *Centaur* vehicle inertial guidance systems. Work to be done at St. Petersburg, Fla.

$2,900,000—**Algernon-Blair Co.,** for construction of dual-bay building/test tower for full-sized *Saturn V* load testing at Huntsville, Ala.

$1,600,000—**Control Data Corp.,** Minneapolis, for five 924-A *Saturn* vehicle automatic checkout computers.

$425,000—**August Perez & Associates,** New Orleans, for design and construction of engineering facility at the Marshall Space Flight Center.

$138,000—**Electronic Engineering Co.,** Santa Ana, Calif., for electronic timing and synchronization equipment for satellite tracking cameras.

$128,000—**Electronic Engineering Co.,** Santa Ana, Calif., for information processing equipment for *Interplanetary Monitoring Probe (IMP)* program.

$92,400—**Crane Co.'s Hydro-Aire Div.,** Burbank, Calif., for design, development and production of two prototype *Saturn* hydraulic transformers.

$29,000—**Systron-Donner Corp.,** Concord, Calif., for accelerometers.

General Motors Corp.'s Allison Div., Indianapolis, for production of propellant components for the *Apollo* mission (undisclosed amount).

Sperry Rand Corp.'s UNIVAC Div., Philadelphia, for development of a low-power thin-film spacecraft memory system (undisclosed amount).

AEC

$150,000—**Geoscience, Ltd.,** Solana Beach, Calif., for a study of auxiliary nuclear power space systems.

$109,000—**Allis-Chalmers,** Milwaukee, in conjunction with the U.S. Army, for further study of an energy depot system.

INDUSTRY

$50,000,000—**Melpar, Inc.,** Falls Church, Va., from **North American Aviation's Autonetics Div.,** for *Minuteman* missile circuit boards.

$4,000,000—**Minneapolis-Honeywell Regulator Co.'s Aeronautical Div.,** St. Petersburg, Fla., from **North American Aviation's Autonetics Div.,** for production of *Minuteman* accelerometers.

$1,000,000—**General Precision, Inc.'s Aerospace Systems Div.,** Little Falls, N.J., from **Avco Corp.,** for eight sets of guidance equipment.

$500,000—**Greer Hydraulics, Inc.'s Aerospace Systems Div.,** Los Angeles, from **RCA's Aerospace Communications and Controls Div.,** for hydraulic and pneumatic test components for RCA's Multi-System Test Equipment (MTE).

$500,000—**Garrett Corp.'s AiResearch Mfg. Div.,** Phoenix, Ariz., from **Boeing Co.,** for design, production and testing pneumatic and cyrogenic control valves for X-20 *(Dyna-Soar)*.

$382,000—**Radiation, Inc.,** Melbourne, Fla., from **McDonnell Aircraft Corp.,** for design, development and testing of a digital data processing system for *Gemini*.

$93,000—**Giannini Controls Corp.'s Gyro Div.,** Duarte, Calif., from the **Martin Co.'s Space Systems Div.,** for production of a three-axis rate gyro package for the *Gemini* launch vehicle.

$90,000—**Keco Industries, Inc.,** Cincinnati, from **Boeing Co.,** for design, development and production of X-20 *(Dyna-Soar)* air conditioning units.

$46,000—**North American Aviation's Los Angeles division,** from **Ford Motor Co.'s Autonetics Div.,** for testing a new type of aircraft decoy rocket in the division's AeroSpace Laboratories environmental simulator.

Swedlow, Inc., Los Angeles, from **California General, Inc.,** Chula Vista, Calif. for an undisclosed number of reinforced plastic components for the advanced *Minuteman* (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Northern Ordnance, Inc., Minneapolis, Minn., for production of 14 *Tartar* guided missile launching systems. The Mk 13 guided missile systems are highly technical and specialized equipment and require an extended period of preparation for manufacture. As a result the government intends to solicit the above technically qualified firm only, which is thoroughly experienced and knowledgeable in the production of this procurement. It is the government's position that only such a firm can reasonably be expected to deliver quality equipment within a short production lead time. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting should contact the above firm direct, referencing C/N 0248-63. BuWeps Synopsis No. 366-63.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Chamber, environmental, altitude inside dimensions 24" x 24" x 24", operate between minus 300° and plus 600° F and simulate altitude to 100,000 ft.—1 item, IFB MSFC-63-233. Bid opening 4-10-63. Bids may be obtained by calling Huntsville, Ala. 536-7497. Delivery to George C. Marshall Space Flight Center, NASA, Huntsville, Ala.

Navy Purchasing Office
4th and Independence Ave., S.W.
Washington, D.C.

Metal reusable guided missile shipping containers for *Sparrow III*, per Vendorlator Mfg. Co. Spec No. 110-04 and drawings, and as specified in invitation—3000 each. Destination: Lowell, Mass. IFB 600-849-63. Bid opening 4-16-63. Note: An additional quantity of 1500 each is being reserved for firms in labor surplus areas under a partial set-aside.

National Aeronautics and Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

System for obtaining the energy spectrum of gammas and neutrons emanating from areator—1 each. Delivery to Lewis Research Center. IFB C-78158. Bid opening 4-3-63. Copies of IFB will be furnished to the extent available on a first received first served basis.

Negotiations will be conducted with Deutschmann Laboratories, 2391 Washington Street, Canton, Mass., for development of capacitators for space propulsion applications. RFP EP075. Note: For information purposes only. No RFP available.

General Support Div.
Directorate of Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure additional repair parts for rebuilding and and maintenance of the Type II *(Firebee)* target missiles. This synopsis is to publicize possible subcontracting opportunities. All inquiries relative to subcontracting must be referred to Ryan Aeronautical Co., Lindberg Field, San Diego, Calif.

Mauler Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

Request for proposal for the initiation of standardization screening effort on the *Mauler* weapon system. Indefinite deliveries of standardization screening reports will be made to the *Mauler* Project Office. Non-availability of adequate *Mauler* system documentation to support competitive procurement precludes award to other than the prime contractor, General Dynamics/Pomona, a division of General Dynamics Corp., Pomona, Calif. All inquiries relative to subcontracting should be referred to General Dynamics/Pomona.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Chamber, environmental, shaker, inside dimensions 36" x 36" x 36", minus 300° F to plus 600° F. Bids may be obtained by calling Huntsville, Ala., 536-7497. Deliver to George C. Marshall Space Flight Center, NASA, Huntsville, Ala.—1 item. IFB MSFC 63-246. Bid opening 4-17-63.

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The Applied Physics Laboratory, The Johns Hopkins University, has technical management responsibilities for the above missile systems. Current activities include test planning, test conducting, and performance evaluation of the radar, computers, data display equipment, in-flight data links, and launch mechanisms.

Several exciting career positions are available immediately for electronic engineers and physicists who wish to acquire knowledge and experience in complex systems engineering. Respondents should have a B.S. or M.S. and at least three years of applicable experience.

Occasional travel to contractors and test areas in this country and Puerto Rico will be required.

Direct your inquiry to:
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The Applied Physics Laboratory
The Johns Hopkins University

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8633 Georgia Avenue, Silver Spring, Md. (Suburb of Washington, D. C.)

IBM Developing Optical Transistor

AN OPTICAL TRANSISTOR, in which signals are carried by light rather than by electric current, is under active development at IBM's Thomas J. Watson Research Center, Yorktown, N. Y.

The experimental device, developed by Richard F. Rutz, has been operated at high frequencies and is relatively easy to fabricate. Its high-frequency operation can be used in computers, radar and other advanced electronic systems.

While it performs the functions of a transistor, the optical unit operates on an entirely different principle. In the gallium arsenide optical transistor, some of the energy of the incoming electric current is converted to light.

After passing partially through the device, the light is absorbed and frees electrons on the output side. Electrons then pass into the external circuit as output current.

● **Light carries energy**—The effect is as if current were passing through the device, but the energy is actually carried by light.

The main advantage of the device is that light moves much faster than electric charges through the "base," or middle portion. To obtain high-frequency operation in a conventional transistor, the base must be made extremely thin to shorten the time required for the electric charges to move across it. These thin base regions are extremely difficult to fabricate.

The base region in the optical transistor is much wider than the estimated average diffusion length for holes in n-type GaAs so that essentially no holes traverse the base region.

According to Rutz in the March *Proceedings of the Institute of Electrical and Electronic Engineers,* the high speed of response is also evidence that the action cannot be due to diffusion of holes across the base.

Also, he continues, it is believed that the injection responsible for the light emission is due to electrons injected from the base n-region to the emitter p-region.

The device in its present form suffers from low current gain, but may be useful as a fast inverter in the common emitter connection and as an impedance transformer. It has been operated as a one-megacycle oscillator.

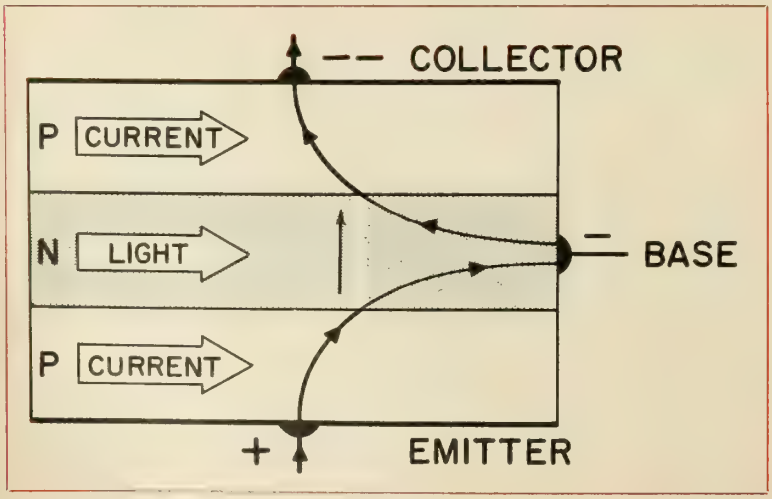
● **Speed biggest asset**—The speed potential of the optical transistor is perhaps its most attractive feature. The ultimate limits on this are not known, but are believed to be in the kilomegacycle region.

Improvements in current gain are possible by removing the highly light-absorbing, heavily doped surfaces of the p-regions and adding reflecting coatings. Early experimental devices have switched signals in 10 nanoseconds, although with some power loss, in an inverting circuit.

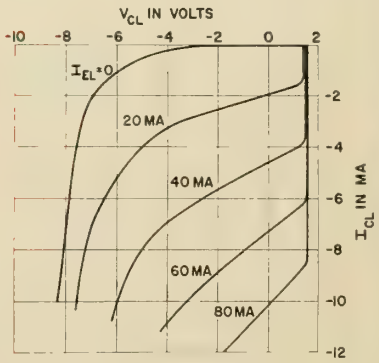
Although the devices made to date have a very low current gain, they show a power gain of as much as 50 at liquid-nitrogen temperatures (77°K). Current gains at room temperature have been at high as 0.1.

IBM experts believe it will be possible to raise the current gain high enough to make optical transistors applicable to the entire range of high-frequency transistor applications. ■

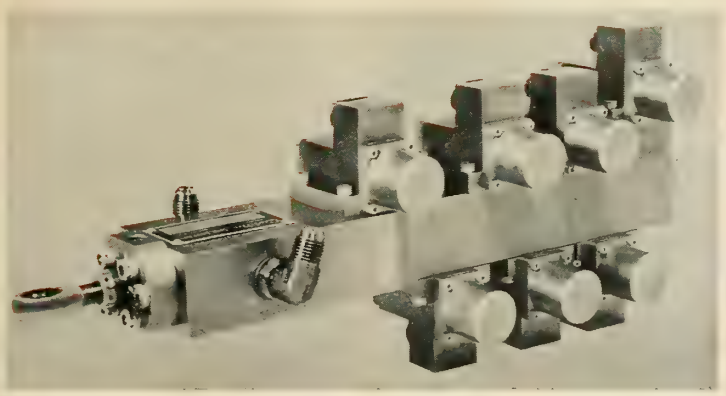
Circle No. 225 on Subscriber Service Card



PRINCIPLES of operation of IBM optical transistor are illustrated here. Electric current enters the device at the emitter. In the region of the junction between emitter and base, light is emitted due to recombination of electrons and holes. Light passes across the base section and creates electron-hole combinations as it is absorbed near the junction between base and collector. As shown, the base is biased negatively with respect to the emitter, and the collector is negative to the base.



GRAPH DISPLAYS the current-voltage characteristics of the optical transistor as measured by IBM experts. V_{CL} is the voltage between collector and base, and I_{CL} is the current into the collector. I_{EL} is the current into the emitter, which is constant for each trace.



New Product of the Week: Digital Servo Actuator

Cadillac Gage Co. is manufacturing a line of digital servo actuators said to be capable of fulfilling many future requirements, such as electrical system compabitility, extreme environmental temperatures, choice of fluid medium, and system reliability.

The digital servo actuator accepts digital computer output signals directly, thus eliminating the digital-to-analog converter and providing electrical system compatibility. Heating or cooling is not required, because the digital servo actuator can operate in extreme temperature ranges.

Since fluid compressibility or viscosity does not affect system reliability, a wide range of either compressible or non-compressible fluids can be used with equal advantage for the digital actutator operation. This allows operation in nuclear environments, where the use of hydraulic fluids is normally impractical. Since a digital servo actuator has no fluid amplification stage, there is no steady state or continuous fluid leakage. And it is not susceptible to fluid contamination because it has no orifices, nozzles, or gaps.

Many causes for control system failures have been traced to the system feedback loop. Because these actuators require no feedback loops, this potential problem is eliminated. An open loop system is employed which moves as a result of input signals until positive contact is made with a stop. Servo loop stability limitations do not exist, and much higher accuracy and velocity specifications can be met.

Circle No. 226 on Subscriber Service Card

Video Amplifier Tube

Sylvania Electric Products Inc. is marketing a strap frame grid video amplifier tube that offers improved performance and, if desired, permits the removal of one of the IF stages.

The tube, designated 6/10LB8, is a triode pentode, utilizing a T-9 bulb and miniature 9-pin base. Combined with the pentode video section in the envelope is a general-purpose medium-mu (approximately 30) triode intended for use as a voltage amplifier or sync separator.

Circle No. 227 on Subscriber Service Card

Silicon UHF Transistor

An ultra-high-frequency silicon transistor has been developed by the Radio Corp. of America for applications in military, industrial and space electronics.

The unit extends the upper frequency limit of silicon transistors to more than 1,000 megacycles and can be used in radar and telemetering receiving equipment, missile testing, and outer space communications.

Substantial extension of the broadcast area covered by a typical VHF communications system is possible through the higher gain and lower noise ratio characteristics of the device.

Circle No. 228 on Subscriber Service Card

Servo Amplifier

The Atchley Model 32-46 servo amplifier, available from the Aerospace Div. of American Brake Shoe Co., is a fast-response, high-natural-frequency unit designed to drive servo valves in hydraulic or pneumatic servo systems.

The device claims built-in versatility for either rack or bench mounting and includes its own power supply. Operating with either d-c or (4 kc) a-c feedback signals, Model 32-46 permits the use of potentiometers, synchros, variable-reluctance devices, and other elements. Octal socket in the chassis allows the addition of plug-in networks for compensation purposes.

Circle No. 229 on Subscriber Service Card

Solar Radiation Simulator

To irradiate satellites and other space vehicles with simulated outer-space solar radiation, a solar radiation simulator (Model ME6) with a four-lens quartz optical system has been developed by Genarco, Inc.

A single simulator can handle a satellite four in. in dia. The unit's zoom optical system enables a testing engineer to reduce or increase radiation intensity by increasing or reducing the size of the irradiated area.

Circle No. 230 on Subscriber Service Card

Load Mismatches

Telonic Engineering Corp. offers a series of 50-ohm load mismatches operating over a frequency range of d-c to 3 gc with a tolerance of 5%.

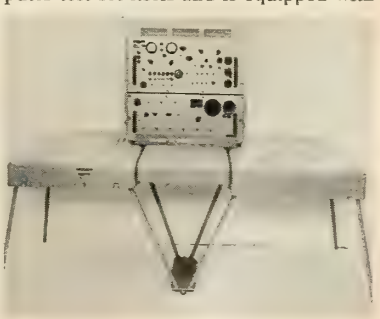
Designed for general-purpose coaxial termination and loading applications, the devices are available in 13 different values: standard match, rated 25-50 ohms with a VSWR of 1.0, plus mismatches of 1.1, 1.2, 1.25, 1.3, 1.4, 1.5, 1.6, 1.7, 1.75, 1.8, 1.9 and 2.0 VSWR.

The TRM-1 series is useful for VSWR "go/no-go" calibration applications. They may be used with VSWR measuring devices such as Telonic's Model TRB-1 Rhotector to determine reflection coefficients; and as standard terminations for 50-ohm systems.

Circle No. 231 on Subscriber Service Card

Military Case

Zero Manufacturing Co. is marketing a military case that can be assembled into a workstand. The MIL-Spec case houses a computer test set and auxiliary operational equipment. The top section of the case is also one end of the workstand. The middle section of the case encloses the computer test set itself and is equipped with



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Resumes are invited from men with several years applicable experience. BS or MS in EE or Physics is preferred.

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from ME's and ChE's with backgrounds in rocket components, chemical processing, rocket motor testing, vacuum testing, propellant processing and propellant chemistry.

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latches, handles and gasketed closures to mate with both the upper part of the case and the bottom section. The bottom section is also an end of the workstand.

The deep-drawn, all-aluminum cases can be equipped with a pressure equalizer, a humidity indicator and other special accessories to meet applicable military specifications.

Circle No. 232 on Subscriber Service Card

Line-Driven Chopper

The Solid State Electronics Co. has available its Model 64 plug-in line-driven chopper.

The unit incorporates the addition of a transformer-coupled isolation drive network and clipping diodes so that it can, for example, be driven from a 400-cycle sine-wave power line or from a drive source that is common to the d-c voltage being chopped.

Sinusoidal or square-wave drive may be utilized over a frequency range extending from 70 cps to 10 kcps sine wave or 40 cps to 12 kcps square wave. It is capable of linearly switching or chopping voltages over a wide dynamic range that extends from to a fraction of a millivolt up to 10 volts.

Circle No. 233 on Subscriber Service Card

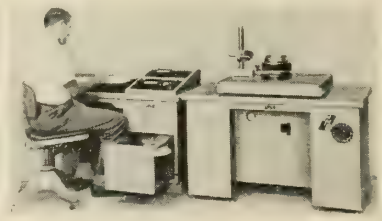
Solid-State Power Supply

Developed by Tylan Corp., a solid-state d-c power supply occupying space less than four sq. ft. has an output of up to 2000 amps at 0-18 v. It is designed for use in research laboratories to operate high-temperature furnaces, magnets, liquid-metal pumps and liquid-metal boilers. Output current or voltage is regulated to 1% in standard models, and provisions are available to operate from feedback signals on temperature, pressure or other controlled parameters.

Circle No. 234 on Subscriber Service Card

Proficorder Rotary Table

A Proficorder piloting unit, for use in obtaining magnified roughness, waviness and total profiles around surfaces of rotation, is available from Micrometrical Mfg. Co. Type RLG is said to be particularly convenient for profiling several surfaces on the same piece—as for checking concentricity, squareness of grooves or shoulders to ID's OD's, and parallelism of horizontal surfaces.



The work-piece—mounted on a circular table of 8-in., 12-in. or 15-in. dia.—is rotated past a stationary tracer. The tracer is quickly located on successive surfaces, at any height up to 12 in. from the top of the table. Absence of fixed columns and overhead parts allows free access to the work from all directions, and work can be of any height.

Circle No. 235 on Subscriber Service Card

Pulsed Magnetrons

Pulsed magnetrons in the millimeter wave range are available from Litton Industries Electron Tube Division. Four fixed-frequency oscillators, operating at 35,000 megacycles, provide peak powers from 5 to 100 kilowatts and average powers from 5 to 40 watts.

The L-3751 provides a peak power of 5 kw at a 0.001 duty cycle; the L-3752, 40 kw at a 0.0004 duty cycle; the L-3856, 40 kw at a 0.001 duty cycle; and the L-3753, 100 kw at a 0.0004 duty cycle. Pulse duration ranges from 0.1 to 0.5 microseconds.

Circle No. 236 on Subscriber Service Card

Light-Sensing Amplifier

A photo-Darlington light-sensing amplifier, packaged in a TO-18 can with a lens window, is being marketed by Raytheon Co.'s Semiconductor Div.

Designated RM3002, the unit has a light-current sensitivity of 25 microamperes per ft.-candle, with a collector-to-emitter voltage of 12 v. Dark current is 10 nanoamperes maximum at a collector-to-emitter voltage of 20 v. Collector dark current is a 15 microamperes maximum at a collector-to-base voltage of 30 volts.

Circle No. 237 on Subscriber Service Card

Pre-Programming Board

A 1200-contact-size pre-programming patchboard, marketed by Vector Electronic Co., offers all the features of firms's 600-contact size plus a rear-contact design allowing solderless slip-on wiring connections. The slip-on contact slides onto the contact pins at the rear of the patchboard, making a low-resistance connection that can be changed readily. The rear contact also can be soldered, if desired.

Circle No. 238 on Subscriber Service Card

Torsional Pendulum

Plas-Tech Equipment Corp. offers a direct-reading torsional pendulum for measuring shear modulus and damping efficiency of polymers as a function of

temperature and frequency. The instrument is being manufactured under license from the Standard Oil Co.

The direct-recording features of the apparatus facilitate investigations of the effects of molecular structure, crystallinity and composition on the dynamic behavior of materials. A salient feature of the device is the ease with which transition temperatures can be determined.



In addition to manufacturing the torsional pendulum, the firm uses the instrument in its physical testing laboratory, where polymers are continuously being screened and evaluated on a consultative basis.

Circle No. 239 on Subscriber Service Card

PPM Klystron

Eitel-McCullough has developed an S-Band klystron—designated X3029—which weighs only about 35 lbs., as periodic permanent magnets are used for beam focus. The unit has potential applications in phased-array radar and airborne or satellite communications.

The device was designed for 75-kw peak output and has been tested to 100 kilowatts. It is 5 in. in dia. and 24 in. long.

Frequency: 2855 mc; beam voltage (peak): 26 kv; beam current (peak): 9.4 amps; and gain: 60 db.

Circle No. 240 on Subscriber Service Card

Vibration-Shock Computer

MB Electronics is marketing a computer that can solve a variety of problems related to vibration and shock. Among the unknowns that can be determined in linear and rotary vibration situations are acceleration, velocity, displacement and suspension natural frequency of the object under study. In shock situations, the following factors can be calculated: package clearance requirements, acceleration level, drop height, horizontal displacement under sudden stop and suspension natural frequency.

Circle No. 241 on Subscriber Service Card

Sound-Level Meter

B&K Instruments, Inc., is marketing its Model 2203 portable condenser-microphone-equipped sound-level meter. Reported accuracy is ±1 db from 20 to 15,000 cps over the full scale range of 22 to 134 db. The instrument is said to be completely stable; accuracy is un-

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Ground Handling Equipment: Swivel joints and assemblies to handle hydraulic, pneumatic and fuel systems on launching vehicles and missile transporters. Units for rotation in 1, 2 or 3 planes in widest variety of metals, pressures and temperatures available.

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Specifications: Corrosion resistant steel, nickel, brass, aluminum, bronze and other metals available for temperatures ranging from −320° to 600°F, pressures from 28″ vacuum to 15,000 psi in sizes ¼‴ to 16″.

For more information send for Chiksan Aircraft and Aerospace Catalog.

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Circle No. 9 on Subscriber Service Card

affected by humidity or any temperature encountered by a hand-held instrument. The unit is insensitive to a magnetic field, and can be used around any kind of electrical machinery or apparatus, B&K says.

Circle No. 242 on Subscriber Service Card

Antenna Measure Unit

Developed by Scientific-Atlanta, Inc., an antenna measurements receiver covers the 20-mc-to-100-gc frequency range.

Designated the R-1600, the receiver features a direct-reading, linear operating frequency dial accurate to ±1%; electronic and servo-tracked AFC; and transmitter residual FM cancellation. Sensitivity ranges from −100 dbm at 20 mc to −75 dbm in the 60-100-gc band.

Circle No. 243 on Subscriber Service Card

Optical Chopper

An optical chopper has been developed by the American Time Products Dept. of Bulova Watch Co.'s Electronics Div. for use in circuits and instruments using either light or radiation sources ranging from ultraviolet to infrared.

Bulova's Type 42 uses a tuning fork as its balance vibration mb. Electromechanical specifications include a range of fork frequencies available from 10 to 1000 cps. Apertures vary in size from 0.3 mm for 1000-cps units to 10 mm for 10-cps units; length is 10 mm. Input power required is 150-milliwatts at 28 volts.

Accuracy of Type 42 is said to be 0.05% in an operating temperature range of −55° to 85°C.

Circle No. 244 on Subscriber Service Card

Fiber Optic Cathode

A high-energy fiber optic cathode ray tube with ultraviolet light output is available from Litton Industries Electron Tube Division.

The tube is designed primarily for direct-exposure applications on 35-mm. film.

The E2A16B is for use with the fast, dry-process films. When used with these films, the high resolution, high contrast capabilities of the tube and film make possible a "near-real-time" projected large-area display.

Other applications for the device include information storage and retrieval, as well as high-efficiency image conversion.

Circle No. 245 on Subscriber Service Card

Available in April
Armed Forces Management's Hardware Catalog

Can you use a reference guide to key military programs and projects? One is available. This "Hardware Catalog" will be printed in April AFM—our Annual Forecast Issue ■ The Catalog will list all major military hardware programs and projects, including: Project/Code Name—Military Nomenclature—Buying Service/Agency Project Manager—Status—Description/Use—Prime Contractors—Current Funding Programs ■ Reprints of only the Hardware Catalog will be available for $1.00 each ■ For an even deeper insight to your military market, buy the entire April issue for $2.50. It will include an analysis and forecast by key Defense officials of future buying plans in such major areas as the booming military aircraft market, missiles, battlefield mobility vehicles, anti-submarine warfare weapons, and many other important market areas ■

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Miniature Circuit Breaker

A snap-action miniature circuit breaker for regulating temperature and current flow in electric motors and electronic circuitry is available from Sylvania Electric Products Inc. The Thermo-Snap provides fast, positive thermal response and long contact life. The glass-encapsulated, hermetically sealed breaker contains an inert gas that provides faster heat conduction and prolongs the life of the contacts by reducing oxidation.

The unit is electrically rated for 5-amp., 115/240v continuous duty. The breakers cover a temperature range from 80° to 180°C and can be specified in tolerances of ± 5, 7, or 10°C.

Circle No. 246 on Subscriber Service Card

Measuring Receiver

A measuring receiver for point-by-point and swept-frequency measurements, the USWV Selektomat, is available from Rohde & Schwarz Sales Co., Inc. Featuring automatic gain control and automatic frequency tracking, the unit permits scanning and tuning to the input signal as well as inertia-free tracking of a changing frequency.

Frequency range of the device is 30 to 400 mc. For automatic operation, the receiver is tuned to one of seven bands within this range. It will then seek and tune the most powerful signal encountered.

Circle No. 247 on Subscriber Service Card

Portable Megohmmeter

A portable megohmmeter that can measure resistances as great as 10 million megohms at 500v d-c or one million at 50v, are available from Associated Research, Inc.

The Model 2850 Vibrotest megohmmeter is powered by line alternating current and provides direct-reading resistance measurements in a four-inch-long scale calibrated from 1 to 100 megohms.

The range may be multiplied by 1, 10, 10^2, 10^3, 10^4 and 10^5 by means of a rotary selector switch. Six megohm ranges are available at either 500v d-c, ±2 volts; or 50v d-c, ±5 volts.

Circle No. 248 on Subscriber Service Card

Delay Line

Vidcor Components Div. of Video Color Corp. has available a variable delay line, 800 ohm, Part Nos. DV 11-5 and DV 145ZS. These devices have a variable delay of 1.10 microseconds, and a fixed delay ranging from zero to 1.25 microseconds, rise time from 0.20 microseconds to 0.30 microseconds and attenuation from 30% max. to 35% max.

Circle No. 249 on Subscriber Service Card

—when and where—

APRIL

American Institute of Aeronautics and Astronautics, Launch and Space Vehicle Shell Structures Conference, El Mirador Hotel, Palm Springs, Calif., April 1-3.

Eighth Midwestern Mechanics Conference, Case Institute of Technology, Cleveland, Ohio, April 1-3.

Progress in Electrical-Electronic Equipment Exhibit, Kiel Auditorium, St. Louis, Mo., April 2-4.

American Society for Quality Control, Annual Quality Control Conference, Sheraton Hotel, Akron, Ohio, April 6.

American Institute of Electrical Engineers, Biennial Electric Heating Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., April 9-10.

Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by ASME, IAS, AIEE, IRE and University of California, University of California, Berkeley, Calif., April 10-11.

Electrochemical Society Spring Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., April 14-19.

International Symposium on Optical Masers, sponsored by Polytechnic Institute of Brooklyn, IRE, Optical Society of America, AIEE and U. S. Defense Research Agencies, New York City, April 16-18.

AIEE and IRE International Nonlinear Magnetics Meeting, Shoreham Hotel, Washington, D. C., April 17-19.

Institute of Environmental Sciences, Technical Meeting and Equipment Exposition, Statler-Hilton Hotel, Los Angeles, April 17-19.

Institute of Radio Engineers, Southwestern Conference and Electronics Show, Dallas Memorial Auditorium, Dallas, Tex., April 17-19.

American Astronomical Society Meeting, University of Arizona, Tucson, Ariz., April 17-20.

AIEE Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, Ohio, April 22-23.

IAS National Meeting on Manned Space Flight, Dallas, Tex., April 22-24.

American Physical Society Meeting, Washington, D. C., April 22-25.

Hypersonic Ramjet Conference, sponsored by ASME, ARS, and U. S. Naval Ordnance Laboratory, White Oak, Md., April 23-25.

National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla., April 23-25.

AIEE Power Industry Computer Application Meeting, Westward Ho Hotel, Phoenix, Ariz., April 24-26.

AIEE Southeast District Meeting, John Marshall Hotel, Richmond, Va., April 24-26.

IRE Regional Technical Conference, San Diego, Calif., April 24-26.

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The Air Force and Gemini

ONE THING to be remembered when tracing the tragic history of the *Dyna-Soar* project is the importance of the program mission. The mission, not the particular vehicle itself, is paramount.

With this thought in mind, the personal conviction of Secretary of Defense McNamara that *Gemini* rather than *Dyna-Soar* may be better able to perform the mission and perform it earlier takes on new significance. This was the major conclusion, or indeed confirmation, about the programs that the Secretary drew from briefings at Houston and Seattle.

There is little doubt that *Dyna-Soar* has been reviewed, revised, reoriented, restudied and reorganized to a greater extent than any other Air Force program. For well over two years, contractors and the Air Force have been urging a full-speed effort on *Dyna-Soar* which would have gotten it firmly under way before *Gemini* was in existence. In May, 1961, when this magazine asked the National Aeronautics and Space Administration what was to fill the gap between *Mercury* and *Apollo*, there was no answer. *Gemini* has flowered since then.

But flower it has—while *Dyna-Soar* has faded. Therefore, both the Air Force and the industry must take a good look at where the two projects stand today in relation to each other.

When Secretary McNamara points out that *Gemini* will be launched in 1964, while *Dyna-Soar* will not be ready until 1966, he presents a telling argument. The delay which put *Dyna-Soar* in this position may be lamentable but it cannot be argued away.

Therefore, attention must be turned to the mission or missions at which *Dyna-Soar* was aimed. This is the primary concern—the U.S. capability and willingness to develop the advanced space technology in this field and to be prepared to meet operational requirements as they arise.

We wrote our eulogy to *Dyna-Soar* on March 11. It must not become a eulogy to a manned military space program, however. It is necessary to examine the alternative.

The question becomes: Can *Gemini* fulfill the *Dyna-Soar* mission?

Secretary McNamara obviously thinks it can. And there are many sound arguments to support his position. *Gemini* cannot do, and never will be able to do, all the things *Dyna-Soar* might accomplish. The controlled re-entry of the *X-20* offers a capability unduplicated by *Gemini*. Because *X-20* is a different vehicle, it will offer some varying capabilities still unforeseen. Are these sufficient to justify two somewhat parallel $800-million programs?

Secretary McNamara does not think so. He may be right IF . . .

IF the Air Force is given management of *Gemini* and *Dyna-Soar* is not dropped entirely.

The Secretary's contention that it is the in-orbit capability which must be the initial consideration is a sound one. But development of military capability in the shape of fall-out from a NASA program is not sufficient. The program must be Air Force-funded and its management made plain.

In recent days, Secretary McNamara has gone much further than ever before toward a clear definition of the NASA and Air Force positions in *Gemini*. NASA's interest in *Gemini*, he points out, is solely in its contribution to the manned lunar landing effort of *Apollo*—not in its potential as a separate space research program. It is the Air Force and the Air Force only, the Secretary notes, which is interested in development of near-Earth orbit capabilities for reasons other than contributions to *Apollo*.

Mr. McNamara also has gone far toward alerting Congress to the fact that *Gemini* is no longer a NASA-managed program, that the Dept. of Defense input is considerable.

ALL OF THESE SIGNS point in the direction of a revitalized *Blue Gemini* program. We would be very much in favor of this. NASA's role in *Gemini* is a transitory one, and it would make far more sense to put both the management and the funding for *Gemini* in Air Force hands, with sufficient guarantees that the temporary NASA requirements will be met.

This could be accomplished because already, as Mr. McNamara told Congress, "In a sense, the Air Force is managing the project and NASA is not." He was referring largely to procurement, but the Secretary also noted that responsibility for *Gemini* planning is not solely, or even primarily in the hands of NASA. It is assigned to the DOD-NASA joint project board.

Mr. McNamara has made the direction clear and he also, quite plainly, has told the Air Force to get with it. In testimony before the House Appropriations Committee, the Defense Secretary stated:

"I think that after the Air Force fully understands the *Gemini* project and is acquainted with the extent to which the *Gemini* project may add to the Air Force's knowledge of manned flight in space, and the extent to which perhaps the *Gemini* project can be modified with relatively slight effort to better meet the Air Force's needs for capabilities in manned spaceflight, it may be possible for the Air Force to cut back the *Dyna-Soar* project substantially."

The Secretary also spoke of cancellation of the *X-20* program. We hope he will not, in the interest of economy, find it necessary to go that far.

Dyna-Soar reduced to a research program similar to the *X-15*, still can make a useful contribution of new technology in an area still unknown. Money spent for that purpose will be well spent.

But, whatever research role it might be assigned, *Dyna-Soar* has become a dead-end program. To fulfill the future missions for which *Dyna-Soar* was intended, we most strongly urge assignment of the *Gemini* program to the Air Force as soon as possible. We are even willing to concede to Mr. McNamara's argument that it may turn out to be the better of the two routes—if it means a full recognition of Air Force requirements in space.

William J. Coughlin

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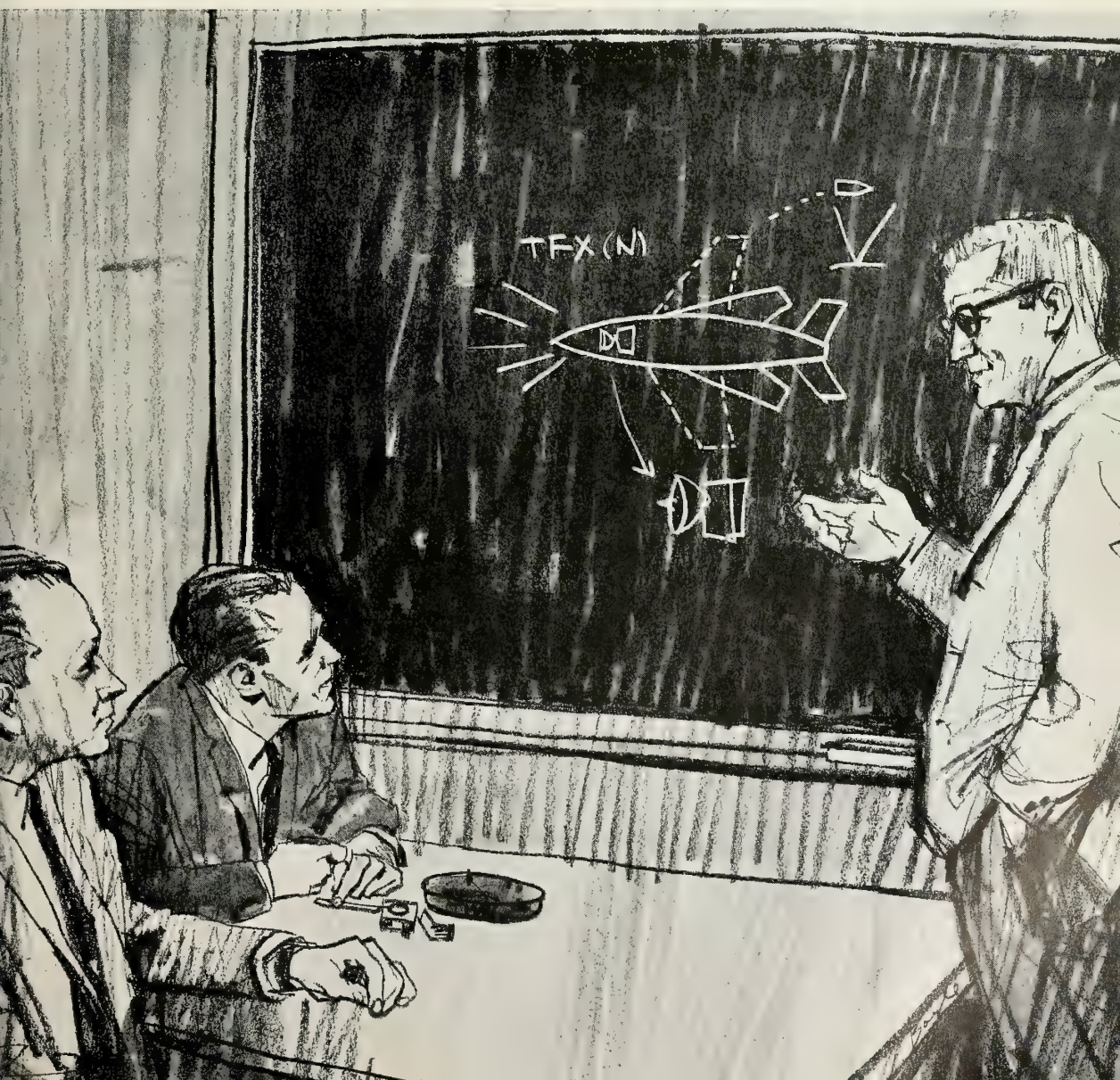
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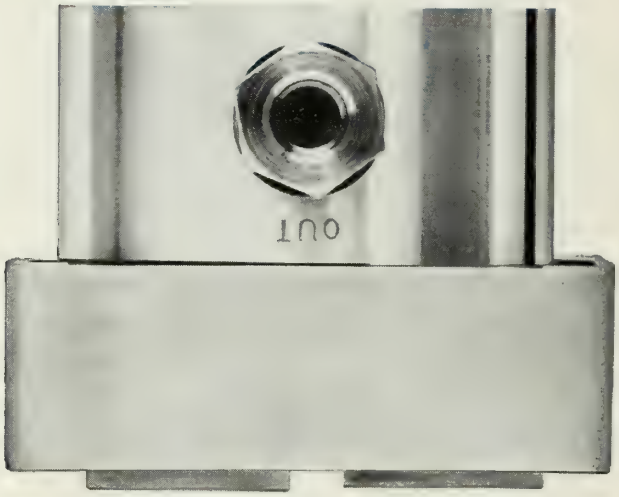




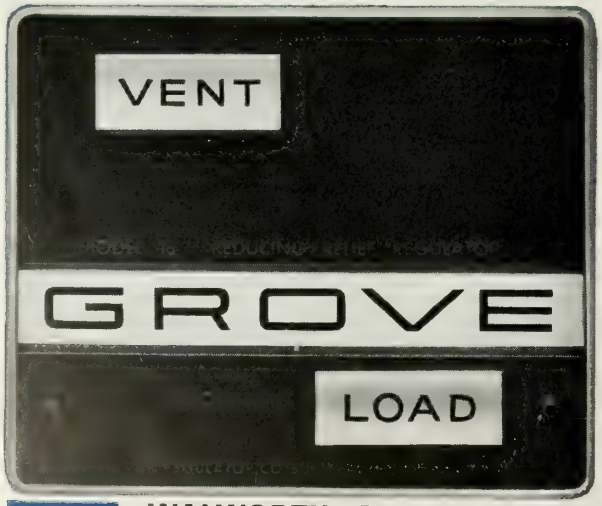
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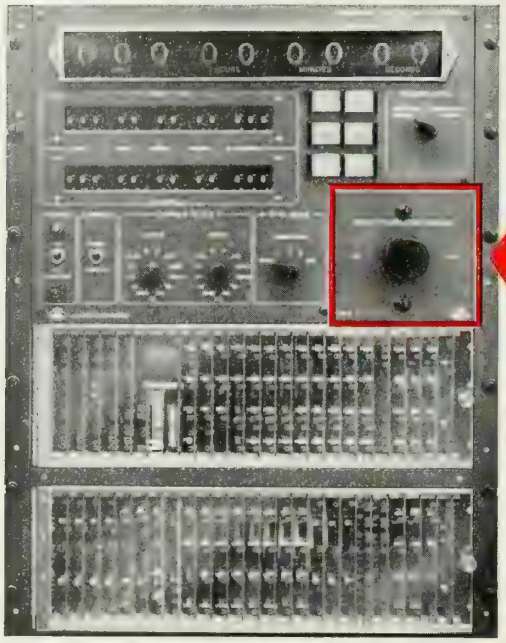


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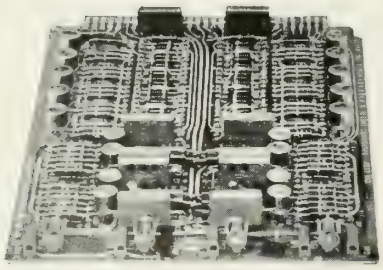


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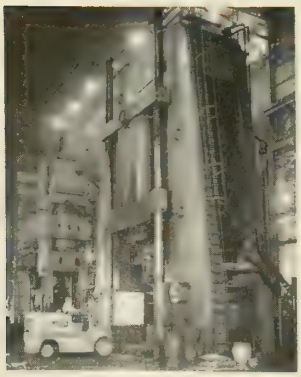
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missiles and rockets

Volume 12, Number 14 April 8, 1963

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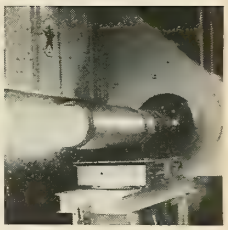
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Air turborocket, Mach 3 engine in advanced development at Texaco Experiment Inc. has generated 1600 lbs. of thrust. The 135-lb. engine is leading to a Mach 0-8 air-breather, for which flight hardware is being assembled. See p. 12.

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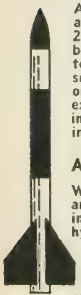
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letters

Military Systems Issue

To the Editor:

Let me add my congratulations for your finest issue yet. I refer, of course, to your March 25th "Military Systems Issue."

W. W. Bailey
Director/Government Planning
Philco Corporation
Philadelphia

To the Editor:

Your issue of March 25 is a fine one and I think you did well. Congratulations.

I noted one paragraph in the Navy section on page 100 that gives me pause, however. You mention that a change in the organization of the Navy "would call for having the Joint Chiefs of Staff report directly to the assistant secretaries, rather than reporting directly to Secretary Korth."

It occurs to me that Generals Taylor, Wheeler and LeMay might view this change in organization and reporting procedures with some dismay.

Fred Korth
Secretary of the Navy
Washington

Dismay, indeed!—Ed.

GEP Mirrors

To the Editor:

I was pleased to read your interesting article on the Goddard Experimental Package (GEP) relative to the *Orbiting Astronomical Observatory* (M/R, March 4, p. 22).

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(Macro) Operational

To the Editor:

I want to thank you for publishing my letter in M/R, March 11, in which I pointed out the importance of the interview which your Senior Editor William Beller and Associate Editor Frank G. McGuire had with Dr. von Karman (M/R, Feb. 25, p. 22), including the subject of "theoretical engineers," a term which these editors proposed and which Dr. von Karman found acceptable. Dr. von Karman said: "I like that term 'theoretical engineer.'"

In my letter I defined briefly the (macro) operational point of view in Physics, following the late Prof. P. W. Bridgman of Harvard, and identified this point of view with that held by the "theoretical engineer." The word "performance" occurs twice in this definition, but unfortunately one of them was left out by your typesetter (about the middle of the fourth paragraph), leaving the meaning a bit cloudy. Since this is a key definition, I wonder if you can find space to give this definition again: "The operational point of view in Physics holds, among other things, that comprehension of all physical laws is possible in terms of (gross or macro) apparatus performance and the concepts which this performance generates." The study of macro *configurations* of apparatus is implied by this definition.

William Bender
Professor of Physics
Western Washington State College
Bellingham, Wash.

WW II Case Cleaning

To the Editor:

Reference is made to the very interesting article "$80,000 Saving Per Case Foreseen," by Richard van Osten, (M/R, Feb. 25, p. 31) in regard to using high-pressure water jets to remove solid propellant.

During World War II, Army Ordnance had the job of renovating World War I artillery shells loaded with solid TNT and nitrate mix. This we accomplished with steam jets through the fuze end of the shell.

It seems that both methods do a good job of removing the propellant.

Charles G. Tolson
Contract Administrator
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American Air Filter Co., Inc.
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Name Switch

To the Editor:

On pages 9 & 16 of M/R, April 1, you refer to the IEEE as the Institute of *Electronic and Electrical* Engineers.

Our proper name is the Institute of *Electrical and Electronics* Engineers. You wouldn't want people to call your publication Rockets and Missiles, would you?

Rucelle L. Consigny, III
IEEE Student Member
Illinois Institute of Technology
Chicago

Happens to us, too.—Ed.

Not So Poor Engineers

To the Editor:

Re Mr. Tony Berger's contentions ("Lo, the Poor Engineer," M/R, Feb. 18, p. 6):

Show me a *bona fide* qualified, dedicated engineer, and I'll show you an engineer who does not share these views.

And I may also yell "foul" over the letter's kingpin statement about Von Braun, Von Karman and Rickover doing the least for their fellow engineers! These Kingpins (and quite a few more like them) haven't had much trouble thinking up new ideas, concepts and theories, using only their brains and knowledge as guide lines, and in so doing have opened up entirely new

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areas in engineering which offer unexcelled and unlimited opportunities.

Just what more would you have them do, Mr. Berger? Establish a colony at Waikiki Beach where engineers and pseudo engineers could loll in the sun, to keep their brains hot while awaiting new ideas, designs, and bigger paychecks?

As regards the cutbacks, just being the recipient of a degree does not necessarily ensure competency in the field, any more than a marriage license ensures a good marriage. And as in all things, you prune out the deadwood to ensure maximum results. A good housecleaning never disposes of the valuable, only the useless.

(DISENCHANTED)
Lompoc, Calif.

Wha' Ha' Wi' Skybolt Bled

To the Editor:

At a meeting of the Lafcadio Hearn Society (a brotherhood devoted to nontechnical education of missile engineers), among whose members are some whose livelihood is threatened by the *Skybolt* cancellation, Brother Joaquin Molinero commemorated said cancellation with some verse. As you see, he views *Skybolt's* demise and the resultant British-American diplomatic gum-bump as merely an extension of the age-old Anglo-Irish feud:

"Ould Skeebolt's Gang Agley"

On Columbia's strand twa Gaels there were
Whose names to reveal I'd nae druther.
The one in a large maison blanc did reside,
In a shebeen wi' 5 sides the other.

Their sires from Erin but lately did hail
An' on one thing fer shure you kin bet—
An Irish dislike of the Sassenach
They acquired still in diapers wet.

An Albion's Whitehall the Minister Prime
A nuclear gap did perceive;
Deep penetrations by the RAF
Ike's *Skybolt* alone could relieve.

So the Minister struck a bargain fair:
I'll share R&D, says 'e;
Let bloody *Skybolt* with our Vulcans fly
And your B-47 we'll reprieve.

But the Sassenach nae on twa Gaels did reck—
Noo his nuclear arsenal's bare,
Ould *Skeebolt* pines where woodbine twines.
And the RAF's fu' sair.

The twa Gaels wassail wi' Tara's cup
Fu' o' Innisfail's braw poteen
While USAF bawls from the endless halls
O' Namara's 5-sided shebeen.

Shaddap ye Irish ghosties,
Ye shouldna howl nae mair.
Parnell, O'Connell, ye Fenians!
Yer banshee's wailing spare.

Awa's ye pipes, awa' the drum
Go forth wi' shillelagh, get fu' o' rum.
Ye'll find divil aught to put on the bum
Noo tha' *Skeebolt's* gang agley.

K. Yakumo, Exec. Secy.
L. Hearn Society
Canoga Park, Calif.

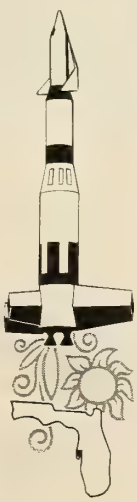
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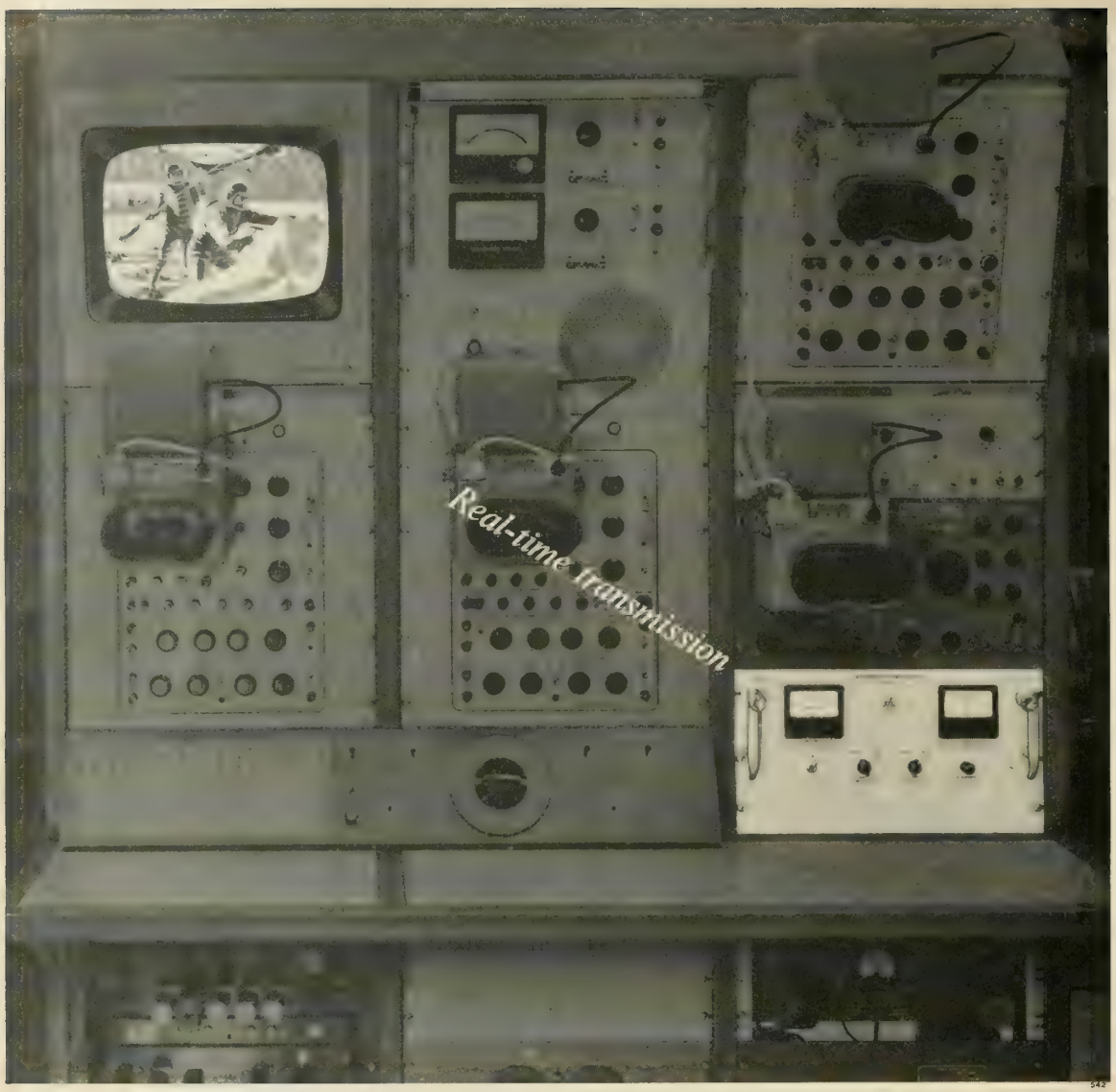
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The Countdown

WASHINGTON

Signing of M-1 Contract Due Soon

Signing of the contract between NASA and Aerojet-General for M-1 engine development is expected in the near future. Surprise feature: a value of some $233 million, a big jump over the $90 million estimated when negotiations began. Behind the increase are several major design modifications.

Big Booster Decision Expected This Month

Air Force consideration of bids in the big solids competition is moving ahead rapidly. Announcement of the winning contractors will be made in two to three weeks. Four separate bids were invited from each firm. But AF still has not indicated whether any one firm will get more than one contract.

NASA to Use Air Transport for Saturn Stage

NASA is expected to switch from barges to air transport to move the Douglas *S-IV* second stage of the *Saturn I* booster from California to Cape Canaveral. Aerospace Lines, Inc., is making further modifications to the Boeing Stratocruiser it rebuilt for the purpose. The Federal Aviation Agency must certificate the aircraft but this could come in time for the first two-stage launch of the *Saturn* booster in July or August.

Lunar Orbit Rendezvous Fight Continues

Scientists at NASA's Ames Research Center have come up with a report which asserts that Lunar Orbit Rendevous is not the most feasible method of achieving certain manned lunar missions. They find no fault with use of LOR for the first *Apollo* mission but insist Earth orbit rendezvous or direct ascent may be better for missions with different requirements. Manned Spacecraft Boss D. Brainerd Holmes told Congress last week he had no question in his mind about the LOR approach. But Dr. Jerome Wiesner, presidential scientific adviser, walked out of a West Coast press conference when reporters repeatedly pressed him on the question of whether he opposes LOR. "I have never said anything about it publicly, I don't want to discuss it," he declared.

Solar Radiation Satellite Is Turned On Again

The Navy's *Solar Radiation Satellite* has been turned on again after 18 months of silently orbiting the Earth. Launched on June 22, 1960, the satellite was shut down on April 18, 1961. NASA scientists turned the satellite on again a few weeks ago. Telemetry signals show no deterioration—an indication that the satellite has successfully withstood high-radiation bombardment.

Award Is No Boost for Dyna-Soar

That $358-million "contract" awarded to Boeing for *Dyna-Soar* doesn't mean much as far as the program's future health is concerned. It is not a money award but a formalization of the amount which would be needed to carry the program through its research and development phase. The "contract" is no guarantee that the program will ever see much of the money. Funding will be incremental and a cutback can scuttle the program. Secretary McNamara already has commented officially on the amount of money which could be saved by scrapping the project before the end of Fiscal '63.

Frick Quits as Project Apollo Director

Charles W. Frick has resigned as director of Project *Apollo* at the Manned Spacecraft Center in Houston, declaring he made the move for "personal reasons." Named acting *Apollo* chief is Robert O. Piland, former deputy. This is the second major change in program management at MSC within three weeks. Previously, *Gemini* project director James A. Chamberlin was replaced by Charles W. Mathews (COUNTDOWN, March 25, p. 13).

INDUSTRY

New Name Announced for Fairchild Division

Fairchild Space and Defense Systems (FSDS) is the new name for the former Defense Products Division of Fairchild Camera and Instrument Corp. Division general manager Robert Bruce says the change was made to more accurately reflect the division's activities and capabilities.

GD/A Delivers Tracking Vans for AMR

General Dynamics/Astronautics has turned over three vans containing GLOTRAC ground stations for the Atlantic Missile Range to the Air Force. Two already have arrived at the Cape, where they will undergo shakedown tests before delivery to operational stations on the range. The GLOTRAC system, which will be integrated with Mark II Azusa equipment, will be able to track vehicles to 23,000 miles in space and determine velocity to better than 6 in./sec. and position within 100 ft.

ARIS Vessels Readied for Trip to Cape

The first of two ARIS (Advanced Range Instrumentation Ship) ships for Atlantic Missile Range was accepted April 2 at Bethlehem Shipyards, Hoboken, N. J. It will be sailed to Port Canaveral after a shakedown cruise. Mrs. H. H. Arnold, widow of Gen. Hap Arnold, will be on hand during May 1 ceremonies when the ship is renamed for the former Air Force chief. Principal speaker at the event is to be Gen. Bernard Schriever. Sperry Gyro Co. is prime contractor on the ARIS ships.

INTERNATIONAL

RAE Will Study British ComSat Design

Detailed design study of a British communications satellite (COUNTDOWN, March 18, p. 9) will be undertaken under the general supervision of the Royal Aeronautical Establishment, Farnborough, and the Signals Research Development Establishment, Christchurch. RAE will deal with the satellite itself and SRDE with communications.

Russian ComSat Spectacular Is Forecast

Alexander Kakunin, Soviet Vice-Minister for Communications, is quoted as saying Russia soon will launch a synchronous system of three communication satellites which will relay TV throughout the world. *Cosmos* satellites will be used for the service—to be called "Cosmos-vision."

Shots of the Week

The Russians launched their fourth lunar probe, *Lunik IV*, on April 2 from a parking orbit about the Earth. The 3135-lb. "automatic station" was reported by Tass, the Soviet news agency, to be close to its planned trajectory on the 3.5-day flight. Mission details were not revealed, but two "possibilities"— a soft landing or a lunar-orbit photographic mission—were mentioned by a Tass correspondent. It is not clear whether the total weight mentioned by the Russians includes only the last stage or the entire payload. At last report, *Lunik IV* was responding to all signals and its equipment was functioning as planned (see p. 14).

• NASA launched the fourth *Saturn I* from Cape Canaveral March 30 in a successful test of the booster's engine-out capability. Number 5 engine was shut off 100 seconds after launch, followed by inboard thrust termination at the 113-sec. mark and outboard at the 120-sec. mark. The vehicle with its dummy upper stages reached an altitude of 80 statute miles and impacted 232 miles downrange. Velocity at engine cut-off was 3650 mph, and 99% of the data from the 610 flight measurement points was usable.

• NASA's stainless-steel *Explorer 17* (*S-6*) satellite entered an almost perfect orbit after being launched April 2 aboard a *Delta* rocket from Cape Canaveral. The 405-lb experiment is gathering information on atmospheric structure and spacecraft orbital characteristics. *S-6* is circling the Earth every 96.4 minutes at altitudes ranging from 159 to 570 miles. Its planned orbit was 90 minutes at altitudes of 155 to 580 miles. The satellite's lifetime is from two to three months and it is responding to all signals. NASA experts had estimated that if *S-6* worked for just two days, it would double existing information on neutral particles in space. *S-6* is also expected to provide data on the effects of high-altitude atmospheric drag.

Israel Buying Hawks

Israeli Defense Minister Shimon Peres sealed final details on the deal to buy *Hawk* antiaircraft missiles from the U.S. during a visit to the Pentagon last week.

After a courtesy call on Deputy Defense Secretary Roswell Gilpatric, Peres got down to business, conferring with DOD's Paul Nitze and top Army officials about the transaction.

Nitze, assistant secretary of defense for International Security Affairs, worked out an arrangement calling for purchase of a number of *Hawks* as well as for training of the crews. Israeli personnel will be trained at Fort Bliss, Tex., and Redstone Arsenal, Ala, beginning in August.



Pershing Passes Arctic Tests, Heads South

ARMY'S MARTIN PERSHING missile shown at Fort Wainright, Alaska, near Fairbanks, where it has completed cold-weather tests. It will now be run through tests at Fort Sherman in the Panama Canal Zone. Alaskan temperatures dropped as low as —55°F, and the tropical tests will be at the highest temperatures available. Testing includes road marches, countdowns and simulated launches.

Gemini Award Sets Record

McDonnell Aircraft Corp. will receive $456.6 million for its work on the *Gemini* two-man spacecraft program.

The contract—largest ever awarded by the space agency—was signed April 2.

McDonnell was selected as the program's prime contractor in December, 1961. Since that time it has been operating under a $145-million "letter" contract which is included in the $456.6-million total.

Under the contract, the firm will provide 13 flight-rated spacecraft. Twelve are to be used for flight missions and the thirteenth is to undergo ground testing. McDonnell also will provide 16 *Gemini-Titan II* adapter modules and nine *Agena* target-vehicle docking adapters. Other equipment to be furnished includes:

—Two mission simulator trainers, one to be located at Cape Canaveral and the other at the Manned Spacecraft Center, Houston. *Gemini* astronauts will "fly" complete simulated missions in the trainer spacecraft.

—One docking simulator trainer to be located at MSC for astronaut docking maneuver practice.

—Five boilerplate spacecraft for a parachute injection seat and landing impact tests.

—Three "static articles," spacecraft of flight-rated structure, for ground-test evaluation of the structural loading through vibration and impact tests.

The contract also specifies terms under which McDonnell is to assist in providing spacecraft prelaunch checkout, servicing, fueling, postflight spacecraft services, trainer maintenance, test programs, spare parts, and mission engineering analysis.

McDonnell has approximately 1500 subcontractors or direct suppliers, the NASA announcement said.

Defender Gets New Aide

Dr. Samuel J. Rabinowitz has been named deputy director for Ballistic Missile Defense in the Advanced Research Projects Agency (ARPA). As assistant to Dr. C. M. Herzfeld, he will participate in Project Defender, the ARPA studies on missile defense.

Dr. Rabinowitz formerly was with Columbia University's Electronic Research Laboratories.

Escape From Orbit Studied

The Air Force is studying ways for its astronauts to escape from orbit if they run into trouble. The study includes both emergency descent in the vehicle and crew escape from the vehicle itself.

AF Systems Command's Flight

Dynamics Laboratory is directing the investigation, which is being conducted by Armour Research Foundation. As an example of the problems involved, the Air Force cites the case of a crew that makes an emergency escape over Australia—the resulting landing point being anywhere in the U.S.

ARF is studying a theoretical re-entry vehicle having three or fewer crew members. It will "perform" low Earth orbits, super-orbital re-entries, and short-duration missions. Orbits to be studied include various equatorial, polar, and intermediate types, as well as recovery of the emergency escape system by parachute.

Nuclear Weapon Tests Planned

Safety tests of nuclear weapons will be conducted jointly by the U.S. and U.K. during four research experiments this spring. The tests, which will include no nuclear blasts, will provide data on the scattering of plutonium from accidental chemical explosions involving nuclear weapons.

The Nevada tests will feature the scattering of plutonium from high-explosive test devices, with the fine plutonium particles subsequently inhaled by test animals in the area to determine the dangers involved in such inhalation by military personnel.

Another objective is to determine the effectiveness of concrete bunkers in preventing the spread of such plutonium contamination. Weather contributions to the spread of contamination will also be studied.

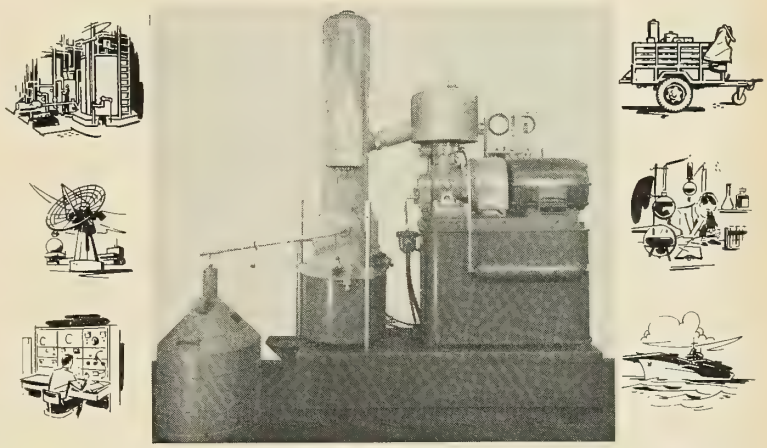
First Biomath Meeting Held

Aerospace medicine may reap some big dividends from biomathematics—a new trans-disciplinary combination of medicine and computer science. This was the consensus of some of the top men in this rather limited field gathered in Houston for the first symposium ever held on the subject.

One example of possible application in aerospace is the development of theory to predict human reaction to drastic changes in environment. Such complex research is not possible without the use of the newer high-speed computers, said Dr. Clifton Mountain, project director of the University of Texas Postgraduate School of Medicine Institute of Biomathematics, and symposium chairman. "Vast new fields of medical knowledge, hitherto impractical for researchers, are being opened up by computer science," he said.



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Engine May Oust Big Booster

Texaco Experiment Inc., developers of powerplant, claim it should accelerate load from standstill to Mach 8 in single mode of operation

by William Beller

RICHMOND, VA.—A hypersonic air-breathing engine is emerging as a potential challenge to large rocket boosters.

Its developer reports that the relatively small and lightweight engine will be able to accelerate a load from standstill to Mach 8 within a single mode of operation.

The powerplant, known as an air turbo-exchanger (ATE), is envisioned as a first-stage booster for orbital payloads and as the propulsion unit for an aerospace plane or hypersonic research vehicle.

In theory, ATE's specific impulse will average 4000 sec. and its thrust-to-weight ratio will exceed 20 in flights across its Mach-number range. This would make the engine an order-of-magnitude better than modern chemical rockets in specific impulse—and nearer rockets than turbo-ramjets in specific weight.

● **Compared with rockets**—Since ATE extracts its oxygen from the air, it can perform a given hypersonic mission with far less gross weight than an all-rocket system. In another view, this means that if the launch weights are kept the same, the vehicle with the ATE stage can carry larger payloads.

Calculations indicate that a 25,000-lb. payload can be launched into a 300-nautical-mile orbit by a three-stage, high-energy rocket weighing 615,000 lbs. The same mission presumably can be performed with a gross weight of only 270,000 lbs., if the first-stage booster is an appropriate ATE unit.

Calculations also show that for an aerospace plane mission, two 6440-lb. ATE engines with 30,000 lbs. of hydrogen fuel can carry 500,000 lbs. on a flight trajectory—one-g average acceleration—from horizontal takeoff to a speed of Mach 6.

● **Mach-3 temperature**—The developer of ATE, Texaco Experiment Inc., of Richmond, Va., is assembling flight hardware for a small-scale engine. The company told MISSILES AND ROCKETS that a unit with a static thrust of 120,000 lbs., a weight of 6440 lbs., and a static specific impulse of 5500 sec. can be built by 1968. It would be 188 in. long and 78 in. in dia. at its intake.

Only Mach 3 facilities will be needed to test the ATE engine. This is said to be an enormous advantage, since a major roadblock in developing hypersonic engines is the lack of sufficiently high-speed tunnels.

ATE will be amenable to "low-speed" testing because, even in the Mach 8 flight regime, the engine will never experience air temperatures greater than Mach 3.

Part rocket, part turbojet, ATE is based on the air turborocket (ATR), which is in advanced development at Texaco Experiment. The ATR, in turn, is based on a decade of company development work and static firings, which stemmed from an earlier Navy program.

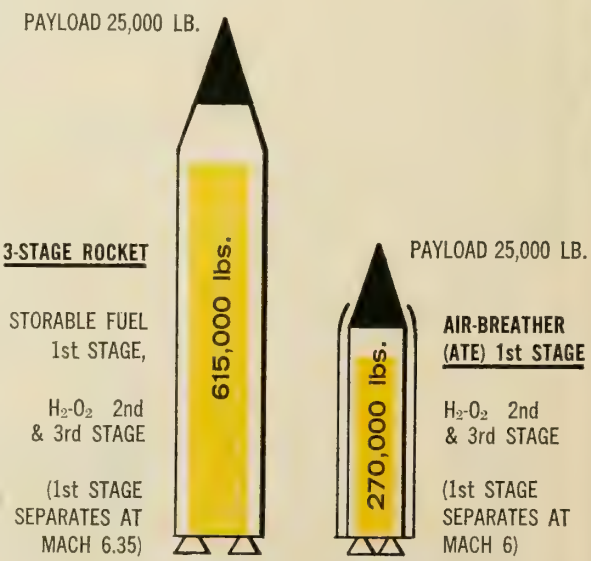
Derived from the turbojet, the ATR spins its turbine with the decomposition products of a monopropellant fuel instead of with incoming air. The turbine therefore can be made relatively small because it is sized to extract work only from the high-energy fuel.

The turbine then drives the compressor through a common shaft, and the compressor taking in the ambient air sends it to the combustion chamber, where the decomposition products of the monopropellant become the engine's fuel.

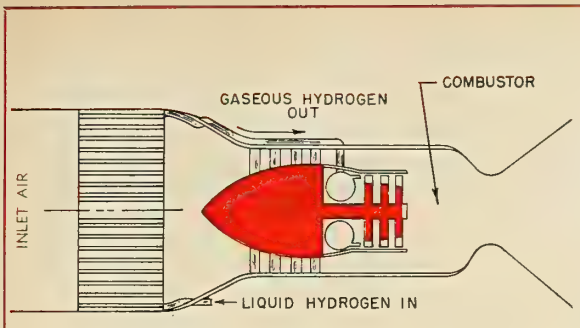
The ATR engine Texaco Experiment is currently static-firing weighs 135 lbs. without its air inlet, has a static thrust of 1600 lbs., and a verified specific impulse between 600 and 1200 sec. across the flight range from standstill to Mach 3. At this speed, the ATR will be above 35,000 ft. and will be putting out 5500 lbs. of thrust, the company says.

This ATR, which has a 12.5-in.-dia. compressor, uses ethylene oxide as its propellant; its main products of decomposition are carbon monoxide, methane and hydrogen. If hydrazine and a different engine design were used, the company says the sea-level thrust-to-weight ratio could be raised from 12 to as high as 30.

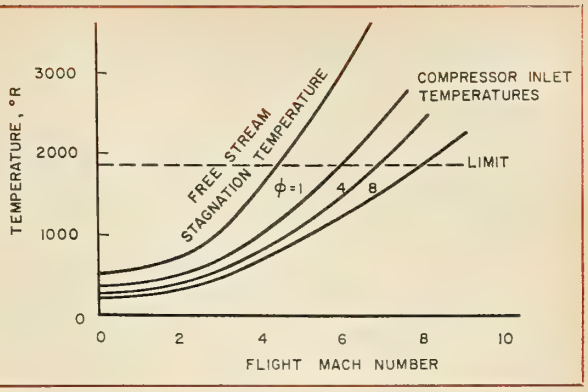
● **Heat exchanger**—If the decomposition chamber and its monopropellant are replaced by a heat exchanger carrying cryogenic hydrogen, the result is the air turbo-exchanger. Located



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AIR TURBO EXCHANGER (ATE) precools inlet air.



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in the air inlet, the heat exchanger cools the ingested diffused air so that the engine downstream will be subjected to a Mach 3 temperature.

The incoming air meanwhile turns the cryogenic hydrogen to a gas which further expands in the turbine. The hydrogen then passes into the combustion chamber, where it reacts with the incoming air. The flow here is subsonic.

Two major advantages stem from this cycle: the air, because it is precooled, is more easily compressed; and the engine experiences an airstream no greater than Mach 3, even though ATE may be flying at Mach 8.

From engine start-up to the low hypersonic range of about Mach 3, the heat exchanger will not warm the hydrogen enough for an efficient expansion through the turbine. A regenerative heat-exchanger is therefore brought into the circuit. Above Mach 3, the regenerative heat-exchanger is bypassed.

To keep the compressor sufficiently cool at the higher Mach numbers, so the temperature limit of the materials is not passed, the hydrogen flow is increased—until at Mach 8 the "equivalence ratio" reaches 8. This ratio is defined as actual-fuel-flow/stochiometric-fuel flow.

At least one segment of the heat exchanger will have to be tested at Mach 8. This is not expected to be a difficult problem, since facilities exist that can furnish the small volume of high-temperature air required. The hypersonic inlet can be tested on a reduced scale in present facilities.

● **Simpler than turbojets**—The company claims that the hardware for ATR, and consequently for ATE, is simpler than that required for a turbojet of the same thrust level—and fewer components are needed.

One reason is that the turbine is no longer aerodynamically coupled to the compressor. This means that the power out of the turbine does not depend on the air flow through the compressor. Conditions such as surge are not critical; there will be no need for variable geometry compressors or air bleeding.

Another reason is that since the air bypasses the turbine the fluid suffers no pressure drop. The full compressor discharge pressure goes into the combustion chamber.

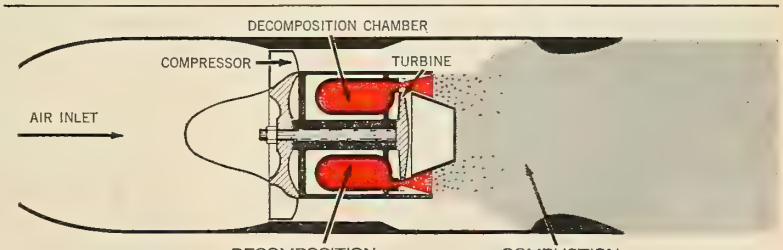
In a typical large turbojet, on the other hand, a 12- to 14-stage compressor produces a pressure ratio of 12. After combustion and turbine work, the overall pressure ratio falls to 2—the number determining engine thrust. Less hardware is needed if the turbine pressure drop can be eliminated.

The turbojet turbine is also doing its work the hard way—under a relatively small pressure ratio of a maximum of 6 across its blades. Where a monopropellant is used to drive the turbine, the pressure ratio across the blades rises to 30. Operating under the lower pressure ratio and driving the larger compressor, the turbine must extract five times as much shaft horsepower as the ATR cycle to arrive at an overall pressure ratio of 2.

An advantage over the ramjet is that ATE does not require a variable nozzle throat area as the engine travels across the Mach number range. Once a ramjet gets beyond Mach 2, its throat must be continuously thinned down until at Mach 8 it reaches about 0.1 its maximum area. ATE would be working at optimum if its nozzle throat area at Mach 8 were cut down to only 0.8 of its maximum.

● **Hypersonic aircraft**—Rockets are the expensive way to get a lift into space, Charles H. Zimmerman, NASA's director of aeronautical research, told the House Space Committee last week. "There are reasons to believe that a hypersonic airplane with air-breathing engines using the oxygen from the atmosphere . . . for global-range Earth transportation or for boosting a second stage like the *X-20 (Dyna-Soar)* into orbit will be much more economical."

For the hypersonic mission, Zimmerman envisions a craft whose first-stage booster is an (HTOHL) hypersonic-cruise airplane with air-breathing propulsion. At the optimum hypersonic speed and altitude, the airplane launches a second-stage, rocket-propelled carrier capable either of orbital rendezvous with a space station—or of the simpler Earth mission. ■



	PRODUCTS MOLE — PERCENT	TEMP. °F	MONO-PROPELLANT IMPULSE	TEMP. °F	HEAT BTU/LB	HIGH ALTITUDE PERFORMANCE	STOICH. AIR/FUEL RATIO
HYDRAZINE 65	CO-6% CO_2-1% CH_4-7% H_2-47% H_2O-10% N_2-29%	1745	215	3745	6 650	VERY GOOD	4.0
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CHARACTERISTICS of air turborocket (ATR) monopropellants.

New sense of urgency . . .

Lunik Boosts NASA Funding Hopes

Fulton opposes heavy cut; Mansfield for speed-up; Saturn and S-6 successes brighten prospects

by Hal Taylor

THE LATEST Soviet moon shot and some unexpected support from the ranking Republican on the House Space Committee have sharply improved the outlook for NASA's Fiscal 1964 budget.

Two successful space agency launches—*SA-4* on March 30 and the *S-6* satellite on April 2—also are contributing to the improved climate.

Rep. James Fulton (R-Pa.) told MISSILES AND ROCKETS he does not favor a large reduction in the NASA budget.

Fulton said he would like to see the budget trimmed by about $200 million, far below the demands of some other Republican leaders, including former President Eisenhower.

While the $200 million appears large, it represents only about a 3% cut in the 5.7-billion request. In comparison, Congress cut over $100 million from the space agency's $3.8-billion Fiscal '63 budget.

Meanwhile, Congressional supporters of the budget seized on the Soviet's *Lunik IV* unmanned Moon probe to bolster their pleas.

Senate Democratic leader Mike Mansfield said the *Lunik IV* shot shows the need for a speed-up in the U.S. space program—not a cutback as advocated by Eisenhower.

Mansfield declared that he did not think the program was "spongy," a term used by President Eisenhower in criticizing the U.S. space effort.

The Soviet flight, he said, "shows the outer space is important and the money requested by President Kennedy is needed."

● **Two-year gap**—The 3130-lb. probe was launched by Russia on April 2. It was expected to reach the Moon by April 5 or 6.

Although the Russians released no information as to its objective, U.S. officials speculated that it would either orbit the Moon or soft-land on its surface.

In either case, it will mean that the Soviet Union is two years ahead of a similar U.S. effort. The comparable NASA program calls for missions with the *Surveyor* spacecraft beginning in early 1965.

On April 3, the Russians reported that the probe was functioning normally after covering more than half the 230,000-mi. journey. The Soviet announcement said the probe had traveled 134,215 miles in the first 24 hours of its planned 3½-day flight to the vicinity of the Moon.

The Russians said an automatic station aboard the space rocket is expected to reach the area of the Moon, but gave no indication that they would attempt to land it.

The Soviets have launched three previous Moon probes. The first, which went into orbit around the Moon, weighed 3240 lbs. and was launched on Jan. 2, 1959. The second was launched on Sept 12, 1959. It weighed 3326 lbs., and impacted on the Moon on Sept. 14, 1959. *Lunik III* was launched on Oct. 4, 1959. It weighed 3419 lbs., passed the Moon on Oct. 6, 1959, and took photographs of the reverse side.

In discussing the Russian achievement, NASA's D. Brainerd Holmes told Congress that it again shows the Soviet Union is ahead in some fields. But he said no speed-up in the U.S. program is warranted.

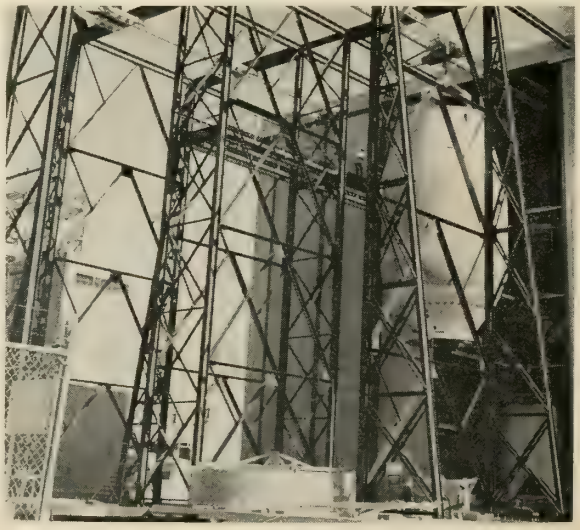
Holmes, Director of NASA's Office



Saturn Progresses

LEFT: *Huge Saturn I rises from Cape March 28 in fourth straight successful test launching.*

RIGHT: *S-IV stage of Saturn is prepared for shipment to the Cape for firing this summer.*



of Manned Space flight, specifically disavowed any crash effort by this country to land a man on the Moon before the Soviet Union.

"I think it would be a foolish thing to squander money on an all-out program just to get there first, just as I think it would be foolish to risk loss of life," he told a House Space Subcommittee.

● **Two up, one to go**—Despite the more spectacular Soviet shot, the two successful NASA missions—*SA-4* and the *S-6* satellite—added further glory to the U.S. space program.

If the upcoming *MA-9 Mercury* flight is successful in mid-May, all three should have a favorable influence on Congressional consideration of the space budget.

Officials immediately announced plans to attempt to wrest away from the Soviet Union the record for the heaviest payloads placed in orbit.

Following the fourth straight successful launch of the *Saturn-I* booster, NASA announced that the *SA-5* and *SA-6* flights later this year both will carry 33,000-lb. payloads. The heaviest Soviet payloads to date have weighed 18,000 to 20,000 lbs.

Dr. Wernher von Braun, Marshall Space Flight Center director, revealed the plans during a post-flight press conference at Cape Canaveral.

He said the *SA-5* flight, now set for late summer, will orbit the *S-IV* second stage and a modified *Jupiter* nose cone.

The *SA-6* flight, due before the end of 1963, will orbit the *S-IV* stage and an upper stage with an *Apollo* configuration.

He said tape recorders and 18,000 lbs. of ballast will be carried on each flight. He added that no attempt will be made to separate the upper stages when they go into orbit.

● **SA-4 triumph**—Launch time of the *SA-4* was delayed 101 minutes by a series of technical holds which included misalignment of the ST-9 guidance platform, replacement of a defective theodolite and bridging a defective microswitch in the automatic sequencer.

The flight went completely as planned. A quick check of telemetry data revealed performances were within one percent of planned parameters.

A Mistram package carried on the flight worked satisfactorily, and accelerometers carried for the first time on *Saturn* performed well in giving yaw and pitch signals to the guidance system.

All engines performed nominally during the flight. Engine 5 was deliberately shut down at 100 seconds to simulate engine failure, but the booster continued to fly. The three remaining inboard engines shut down at 113 seconds and the four outboard engines were cut off at 120 sec.

Shortly after burnout, a tape recorder played back a portion of telemetry data recorded during flight. This verified a new technique which may save data that might otherwise be lost during ionization blackout periods.

The *SA-4* retrorockets fired on schedule and the booster reached a planned apogee of 80 miles before impacting 232 miles down the Atlantic Missile Range.

A post-launch inspection of the launch facility revealed that damage was nominal. Work continued to convert Complex 34 for a Block II *Saturn* launch capability in time for the *SA-6* flight this fall.

● **S-6 flight**—After its other major launch, NASA said that the *S-6* atmospheric structure satellite had achieved a nominal orbit. The satellite is orbiting the Earth every 96.4 minutes at altitudes ranging from 155 to 180 miles. Its expected orbital lifetime is two to three months. NASA said all instruments on the satellite—designed to gather information on neutral particles in space and orbital characteristics of spacecraft—were functioning normally.

The space agency also announced plans to launch a similar satellite late this year.

Principal industrial contractors for the stainless-steel satellite included the Budd Co., Philadelphia, which built the satellite shell, Consolidated Systems Corp., the mass spectrometers; N.R.C. Equipment Corp., Redhead vacuum gauge; Westinghouse Electron Tube Div., Bayard-Alpert vacuum gauge, and Yardney Electric Co., batteries. ■

Next Syncom Launch Attempt Delayed by Modifications

NASA WILL NOT make another attempt to launch its *Syncom* synchronous orbiting satellite until midsummer.

The delay from a planned April flight is caused by several modifications being made to the satellite as a result of its unsuccessful first launch on Feb. 14.

As the satellite reached its 22,300-mi. apogee the on-board rocket was fired. Approximately 20 seconds later, telemetry signals stopped and all but visual contact with the satellite was lost.

Since the spacecraft is in orbit, officials are certain the apogee "kick motor" did not explode. One theory is that vibration forced the satellite to malfunction, but NASA officials frankly admit that they can't pinpoint the problem now—nor are they likely to do so in the interviewing period before the next launch.

They have, however, decided to make two modifications in *Syncom*.

One calls for addition of a separate battery to power one of the telemetry transmitter's antennas and encoders. This will be able to provide power for communications for 15 or 20 minutes without recharging. If the main communication system fails, it is hoped the battery will enable scientists to contact the satellite.

The other modification would change the wiring harness to provide more redundancy. Officials believe the problem could have been caused by a defective wiring connection.

● **The urgency**—A successful *Syncom* launch is especially important because most officials believe the synchronous orbiting satellites will be the best approach to a world-wide communication satellite system.

Leonard Jaffe, director of NASA communication systems, told a House Space Subcommittee recently that three such satellites can thoroughly cover the Earth.

One satellite can cover South America, the East Coast of the U.S. and major portions of Western Europe and Africa. Another can tie Europe to the Far East, and a third one stationed above the Pacific can tie Eastern U.S. to Japan and Australia.

Achieving such an orbit, with current rocket power is difficult, however.

The *Thor-Delta* vehicle launches *Syncom* with its internal rocket into an elliptical orbit with an apogee of 22,300 mi. At that altitude the spacecraft's rocket is fired. Its purpose is to add enough energy to the spacecraft to circularize the orbit. This orbit is almost but not quite the equatorial circular orbit that would be required for a truly stationary satellite. In actuality it is 33° off the equatorial plane, because of the limitations in launching from the Cape with the energy that now is available.

At an appropriate point on this circular orbit the ground control system is called upon to rotate the satellite so that its antenna radiation pattern is properly located with respect to the Earth.

Small reaction jets then keep the satellite in the prescribed orbit.

After Kiwi is successful . . .

Phoebus May Yield 268-lb. Reactor

SNPO favors high-temperature features to compactness at this point in rocket effort; LASL to phase out of Kiwi by mid-'64

by Frank G. McGuire

DEVELOPMENT of *Phoebus* advanced nuclear reactors for space propulsion may yield 7.1-in.-dia. units developing 5500 lbs. of thrust for use in small space vehicles. The program, providing several designs for solid-core reactors following *Kiwi*, will provide a choice of either high-temperature operation or very compact engine systems.

One of the smallest being studied at Los Alamos Scientific Laboratory is a 268-lb. reactor which would form the heart of an engine system weighing less than 500 lbs. LASL expects to phase entirely from the *Kiwi* series of flightless reactors into the *Phoebus* series by mid-1964.

Progress in the *Phoebus* program depends largely on the success of *Kiwi*, which has recently run into considerable development difficulty. NASA Administrator James E. Webb has expressed doubt that *Kiwi's* problems will be solved soon even with a DX priority; nor does he anticipate their solution in time for a supplemental budget request (M/R, March 11, p. 14; M/R, April 1, p. 9).

Harold B. Finger, manager of the joint AEC/NASA Space Nuclear Propulsion Office (SNPO) told MISSILES AND ROCKETS he prefers that initial emphasis be put on the high-temperature operating characteristics available through *Phoebus* rather than making any effort at compactness.

First power tests of a *Phoebus* reactor now are scheduled for early 1965, following component and subsystem tests. Funding is now at a moderate level, and is being handled through the *Rover* program, of which *Phoebus* is an advanced segment.

There is no concrete indication of how many different designs are being worked on under *Phoebus*, but LASL is believed to have core designs worked out for units ranging from just over seven inches in diameter and 5500 lbs. of thrust to 29-in.-dia. cores developing 228,000 lbs. of thrust.

These systems, intended to indicate the potential for the future, all use liquid hydrogen pumped through a solid core.

The first of the series will be called *Phoebus I* and will be approximately the same configuration and dimensions as *Kiwi-B*, but with those changes needed for study of high reactor powers and demonstration of the limit of power density in propulsion reactors.

Work on *Phoebus I* is well under way, and specific design work has begun on *Phoebus II*, which is designed for performance levels based on future propulsion requirements. *Phoebus II* will require a new test cell at the Nuclear Rocket Development Station in Nevada, incorporating special features for the project.

● **Core Characteristics** — Ralph Cooper, a LASL scientist, describes the small fast reactors as several basic types—uranium-tungsten, uranium carbide, uranium-233—and variations.

"There is a wide variety of reactor weights, sizes and compositions from which to choose," Cooper says. Cermets of $U^{235}O_2$-W require about 40 vol % loading to be superior to intermediate, heavily loaded graphite reactors. Uranium carbide offers a spectrum of possibilities ranging from very small, lightweight (about 300 lbs.) pure UC reactors with low exit gas temperatures (less than 2000°), through moderate size and power UC-ZrC reactors, to heavier UC-HfC reactors of high (greater than 3000°) temperature poten-

RELATIVE SHIELDING REQUIREMENTS

Reactor	Diameter (in.)		Wt (lb)		
				Lead shields	
	Core	Reflector (Be)	Engine	10 in. shadow	5 in. circum.
200 Mw UC	10	18	500	1200	2,700
1000 Mw UC–ZrC	18	26	2000	2600	5,200
1000 Mw Graphite	36	48	5500	9000	16,000

SHIELDING and other characteristics of fast reactors for rockets are shown in these tables. Figures are representative and do not necessarily mean hardware exists for each example. Symbols used include Af (flow area) and 1 (fuel loadings). Shadow shielding is between inlet end of reactor and the tankage, while circumferential shielding completely covers the ractor.

U^{233} REACTORS

Fuel	Void	Wt (lb)			Diam. (in.)	Af (ft²)	Thrust[a]	Wt of equivalent[b] U^{235} reactor
		U^{233}	Core	Reactor				
40% UO_2 in W	0.375	150	640	920	13.4	0.37	37,000	2900
40% UO_2 in W	0.625	420	1310	2395	22.1	1.65	165,000	5300
22% UC in ZrC	0.5	183	860	1305	18.1	0.893	89,300	1424
50% UC in ZrC	0.3	70	142	282	8.65	0.12	12,000	620
50% UC in ZrC	0.5	150	355	615	12.9	0.42	42,000	930
20% UC in HfC	0.5	840	4290	5300	29	2.28	228,000	20,000
20% UC in HfC	0.25	450	2270	2820	20.5	0.57	57,000	—
15% UC in HfC	0.2	1230	8230	9330	31	1.05	105,000	—

[a] Based on 2000 Mw ft² flow area
[b] Equivalent means same % composition and flow area

tial. Uranium 233 may be used to lower weights or increase gas temperatures."

Describing the LASL calculations for the American Nuclear Society Cooper noted that feasibility of using fast spectra for small nuclear rocket engines was observed as early as 1949, but that until now no one has carried out a thorough study of the potential.

Criticality of such small reactors presents the least serious problems, and the problems which usually cause major trouble in any reactor have the least effect on this type—a homogeneous and fully enriched design. Void space and fuel element thickness are on the order of 0.1 in. or 1/20 of the neutron mean free path.

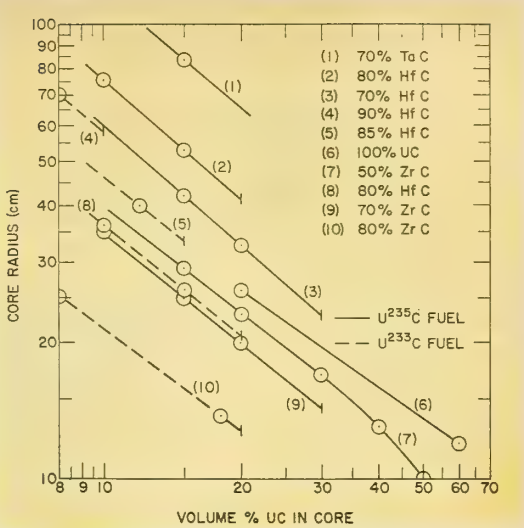
"Because of the effective homogeneity of the core, critical masses will be relatively independent of core details such as fuel element thickness and will depend primarily upon the composition and average void fraction. The achievable power level is contingent on core details, such as heat transfer area, fuel element thickness and conductivity, operating pressure, and exit gas Mach number," Cooper said.

● **UO_2-tungsten class**—Dispersing uranium dioxide fuel throughout a refractory metal such as molybdenum or tungsten is one of the "most obvious" classes of fast reactor nuclear rockets, according to the LASL scientist. The nuclear properties are somewhat similar, but the density of tungsten is about twice that of molybdenum, and has a higher melting point. If the higher melting point were to be sacrificed, however, the reactor weight could be reduced by a factor of two through use of molybdenum, while maintaining the same flow area.

Reflector for the theoretical fast reactors studied at LASL consists of 12 cm beryllium at 75% of theoretical density to allow for coolant flow channels. The idealized reactor type is a cylinder with one end bare, while the sides and other end are reflected. Preliminary criticality estimates use a generality of a right circular cylinder of radius R and height 2R (L/D = 1).

● **UC-metal carbide class**—A more complicated situation exists in this class because uranium carbide forms solid solutions with many metal carbides, and a continuous range of properties exists, depending on the composition. Also, the metal carbides usually have a nonzero (positive or negative) reactivity worth, preventing a simple criticality calculation, and the uncertainties of the carbide mechanical properties may require varying support structure, altering reactor mass.

It is conceivable that an unalloyed uranium carbide reactor could be produced with a melting point of 2450°C, having a limited exhaust gas temperature but useful velocities on the order of 18,000 ft. sec. This type of reactor could weigh between 200 and 300 lbs. LASL studies have indicated, however, that a zirconium carbide would be useful for applications requiring higher performance.



CRITICAL core radii, reflected by 12 cm of 75% dense Be. Curves marked by vol % of one-fissile metal carbide.

● **U-233 class**—This class provides a number of distinct advantages over other types, but only at the expense of considerable radioactivity, some of which is intrinsic, but most of which is due to a contaminant (U^{232}). The advantages of the U^{233} reactor are numerous, including reduction of the minimum size reactor by a factor of two, reduction of reactor weight for a given flow area, increasing the void space and therefore the flow area for a fixed reactor size, altering the power distribution with fixed uranium loadings, or reducing the loadings while maintaining the same core size and void fraction.

High gas temperatures are best achieved with the last of these. ■

REPRESENTATIVE UO_2 REACTORS

Metal	l	Vol % UO_2 in core	Wt (lb)				Core diam. (in.)	Void frac.	Flow area (ft^2)	Thrust[a] (lb)
			UO_2	Metal	Be	Reactor				
W	0.4	0.3	730	2060	530	3320	20.4	0.25	0.577	57,700
W	0.4	0.25	1030	2720	720	4470	24.4	0.375	1.18	118,000
W	0.5	0.4	550	970	380	1800	16.2	0.2	0.29	29,000
W	0.5	0.25	1030	1700	720	3550	24.4	0.5	1.57	157,000
Mo	0.4	0.3	495	730	430	1655	17.7	0.25	0.428	42,800
Mo	0.5	0.25	885	870	560	2315	21.2	0.5	1.23	123,500

[a] Thrust based on 2000 Mw/ft^2 of flow area (50 lb thrust /Mw).

REPRESENTATIVE UC REACTORS

Fuel	Wt (lb)					Void frac.	Core diam. (in.)	Flow area (ft^2)	Thrust[a] (lb)
	UC	Zrc	W	Be	Reactor				
50% UC–50% ZrC	212	107	90	227	648	0.2	11.8	0.152	15,200
50% UC–50% ZrC	436	220	323	445	1424	0.5	18.1	0.893	89,300
30% UC–70% ZrC	257	303	182	327	1069	0.2	15.0	0.224	22,400
30% UC–70% ZrC	524	615	645	655	2439	0.5	23.2	1.42	142,000
100% UC	104	—	50[b]	114	268	0.2	7.1	0.055	5,500
100% UC	266	—	83[b]	213	562	0.5	11.3	0.35	35,000

[a] Thrust based on 2000 Mw/ft^2 of flow area (50 lb thrust/Mw).
[b] Support plate at exit end, otherwise 10 vol % of core.

Senior Technical Men...

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Thermoelectric System. First in line among SNAP reactor systems under development at A.I. is SNAP 10A, a 500-watt system which makes use of a thermoelectric converter to transform nuclear heat directly to electric power. The compact reactor, weighing only about 250 pounds, is cooled by liquid sodium-potassium alloy. Zirconium-uranium-hydride material serves as the combined fuel and moderator. The system requires no active control after orbital startup and has no moving parts. Two developmental prototypes have operated successfully for a total of 375,000 kilowatt hours.

Turboelectric Systems. The 3000-watt SNAP 2, another AEC space reactor system being developed by Atomics International, uses the same reactor as SNAP 10A with provision added for active control. Power conversion is accomplished by a unique turbine-generator which operates on a mercury vapor Rankine cycle. All rotating components—turbine, generator and liquid metal pumps—are mounted on a single shaft which rotates at 40,000 r.p.m. A fully-shielded SNAP 2 system weighs only 1350 pounds, yet can supply as much electricity in a year as 250 tons of batteries.



SNAP 8 is a direct outgrowth of SNAP 2 but produces higher output. Atomics International is responsible to AEC for the SNAP 8 reactor-and-shield subsystem, nuclear systems testing and nuclear safety. Using a mercury vapor turbine-generator, SNAP 8 will deliver 30 kilowatts of power—enough to enable orbital tests of ion propulsion engines. The National Aeronautics & Space Administration is developing the power conversion equipment and will accomplish overall system integration.

Opportunities at A.I. Openings exist for those with BS or MS degrees in general engineering; electrical, mechanical or chemical engineering; metallurgy; mathematics; or physics plus three or more years experience. Assignments include heat transfer, thermodynamics, high speed rotating mechanisms, stress analysis, mass transfer, nuclear analysis and component development. If you are interested in making your mark in this important program, Atomics International invites you to inquire for additional information.

Contact: Mr. H. D. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California

ATOMICS INTERNATIONAL

Division of North American Aviation

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Technical Countdown

ASTRONAUTICS

Glass Fins Added to Apollo

The *Apollo* Command Module has been modified to include two narrow glass fiber strakes, or fins, high on the conical side of the capsule. Reassessment of *Apollo* re-entry dynamics had indicated that the capsule might stabilize with its conical side forward. This could be catastrophic, since it's reported that the shielding on the conical side is inadequate to bear the worst of the heating at lunar return velocity and the astronauts are not positioned to withstand re-entry deceleration in an apex-forward attitude. The low-aspect strakes make the capsule unstable in that attitude; the first dynamic pressure of the atmosphere will swing the capsule into the correct position with the thick, convex heat shield forward and the crew facing opposite the direction of flight. Once the capsule is rotated into the correct position, the strakes become ineffective in the turbulent wake of the capsule. They are designed to withstand the re-entry heating effects that they are expected to encounter in this sequence.

MATERIALS

'Pyroceram' Being Developed in Poland

A production process for pyroceram, utilizing heat treatment of molten glass in the presence of special crystallization initiators, is being developed by the Polish Institute of the Glass and Ceramics Industry. This pyroceram is said to be lighter than aluminum and stronger than steel, exhibiting a bending strength greater than 2000 kg/cm^2 and mechanical strength retention up to 700° C. (*Promyshlennost' Armenii, no. 12, Dec. 1962, 68. English abstract-Current Review of the Soviet Technical Press, March 8, 1963, 60-21441-148 Dept. of Commerce, OTS.*)

Bethlehem To Build Goddard Space Chamber

A thermal vacuum space simulation facility will be designed and built at NASA's Goddard Space Flight Center by Bethlehem Corp. The chamber will have a work area 9 ft. across and 15 ft. long with vacuum capabilities in the 1 x 10^{-8} torr range. Thermal performance through a temperature range of —320° to 500°F will be achieved with a combined gaseous/liquid nitrogen system. Precision temperature control of ±3°F will be possible at any given temperature. This precision control can be had with a uniform heat flux 1 or 2 solar constant heat load. An off-axis columnated solar simulation system will be integrated into the design.

New Tantalum Alloy in Production

National Research Corp. is producing ingots, rods and sheets of a new tantalum-based alloy (tantalum, 8% tungsten, 2% hafnium) with a strength-to-weight ratio claimed to be highest of any of the readily fabricable refractory metals. The alloy has a 3000°F strength—some 400% greater than tantalum and 25% greater than Ta-10-W. The ingot produced by NRC's metal division meets specifications of less than 200 ppm interstital impurities. The ductile-to-brittle transition temperature is —450°F for annealed material, National Research scientists say.

CBS Labs Lubricant OK for Cryogenics

Marshall Space Flight Center has approved CBS Laboratories' dry film lubricant, CLD 5940, for use in contact with liquid oxygen. The NASA center's General Chemistry Section applied the lubricant to stainless steel roundels and tested it in accordance with the applicable military specifications. The CBS dry lubricants are vapor-deposited in layers to an approximate thickness of 0.5 microns.

ELECTRONICS

Skybolt Guidance Tests Continued?

"JC-131 Astro-Inertial Flight Test Program," the unpretentious title of a current Air Force Aeronautical Systems Division R&D effort, is believed to be a continuation of *Skybolt* guidance-system tests. Insiders report that more than 20 of the advanced guidance systems were built by Northrop Corp. before *Skybolt* was short-circuited and that these are now being flight-tested in C-131 aircraft out of Hawthorne, Calif. The program is reported to be funded at $1.5 million.

High-Energy Laser Shown

A laser amplifier/oscillator capable of outputs in the 100-500-joule range has been developed by Radiation at Stanford. Revealed for the first time at the recent Institute of Electrical and Electronic Engineers' conference in New York, the laser employes "a confocal-elliptic-cylinder optical-pumping cavity," the company said, plus charging supply, power-storage bank, trigger generator, and control system. Each of the eight cylinders comprising the cavity contains a 5000-joule flash lamp. Laser pulse duration is of the order of 1000 microseconds and beam divergence is less than ½°, developers report.

SPACE MEDICINE

Depolymerized Yeast Fights Radiation

Protection from radiation may be possible through use of depolymerized yeast, which offers the additional advantage of non-toxicity. Scientists at the Air Force School of Aerospace Medicine have found that human cells gained significant protection after a "yeast" treatment of 24 hours before exposure to 700 roentgens of gamma radiation.

Soviets Explain Acceleration Illusions

In a USSR research report just translated, Soviet scientists gave their explanation of the optical illusions occurring during acceleration and weightlessness. Their laboratory studies with rabbits show illusions (oculogravitational and agravitational) are caused by vertical eye shifts that occur as a reflex effect from the reaction of the otoliths to gravitational changes.

Hypnosis—A Space Tool?

An astronaut trained in self-hypnosis could alleviate pain and discomfort, and even stop the flow of blood from open wounds, says a noted student of hypnotism. Frank M. Frazitta, writing in *Hypnosis Quarterly*, adds that if an astronaut's air-conditioning unit should fail, self-hypnosis could be used to lessen the perspiration rate or make him feel either cooler or warmer. Hypnosis could also be used to stop nausea and eliminate the danger of choking.

Radar Work To Aid Lunar Explorers

Texas Instruments' terrain-sensing research for Army may lead to powerful techniques for Moon expeditions

by Charles D. LaFond

DALLAS—Research into the remote and direct sensing of terrain characteristics may soon yield new and exciting approaches to satellite instrumentation and landing devices for lunar exploration.

The Science Services Division of Texas Instruments, Inc., under Army, Air Force and NASA contracts totalling over one-quarter million dollars, is developing techniques and instruments that could also have extensive commercial application in geological work on Earth.

Principal goal of the Army's terrain-analysis research effort is to develop a multisensor airborne system which can rapidly identify ground characteristics. Such information, if obtained rapidly with reasonable accuracy, obviously would be of great aid to field commanders responsible for moving or defending against armored elements, mobile missile units, and other heavy support vehicles. Several programs at TI have made a major contribution to this effort.

A recently announced follow-on contract from the Air Force's Cambridge Research Laboratories (AFCRL) will enable the company to continue studies leading to laboratory simulation of the lunar terrain for radar analysis.

Concurrently, TI has recently begun a study for NASA's Office of Space Sciences to determine the feasibility of employing gravity meters on or near the Moon for geophysical measurements. A prime target is to determine how well such devices will survive lunar impact.

● **Three decades' experience**—The trunk from which TI's present many-limbed structure has grown originated as Geophysical Service, Inc., over 32 years ago.

The organization is believed to have been the first to employ the reflection method of seismic oil prospecting.

Twelve years ago, in a corporate reorganization, GSI became a subsidiary and integral part of Science Services Division of the then-created entity of Texas Instruments, Inc.

Science Services, through its Geosciences Dept., currently holds eight major government contracts in the field of seismology alone for *Vela Uniform*, a part of the global U. S. nuclear-detonation detection and measurement program.

Among the group's other Earth-sensing efforts was the SATAN (Sensor for Airborne Terrain Analysis) program. In that AFCRL task, TI evaluated a broad spectrum of sensing techniques for use in aircraft terrain-analysis missions. Sensor techniques included radar, infrared, photographic, and scintillation-counter.

Out of this study came an extensive catalog of data which related sensor performance characteristics to a variety of atmospheric conditions, topography and vegetation and to aircraft performance and compatibility. Also developed was a summary catalog of global environmental conditions.

● **Project WESTAR**—After it completed a project feasibility study in the summer of 1961, TI's Science Services Division was awarded a contract to build a radar facility and investigate the relationship of radar re-radiations with specific terrain characteristics. By performing such measurements under controlled conditions, researchers hope to establish a catalog of definitive radar signatures.

The Army Mobility Research Center of the Corps of Engineers Waterways Experiment Station, Vicksburg, Miss., sponsored the second phase of the program, which began in the fall of 1961.

To perform its studies for Project WESTAR (Waterways Experiment Terrain Analysis Radar), TI built a unique open-end anechoic arch. Constructed of weatherproofed laminated wood, the arch is a half-cylinder having a 50-ft. radius. Two tracks are secured along the inner circumference to support and permit 60° travel of a radar antenna carriage.

The carriage supports four paired antennas for K_a-, X-, C-, and P-band operation. Except for the P-band radar, the system design permits actual far-field, full-radar cross-section measurements, says Dr. Allen Feder, TI project manager. The facility also provides a precise range gating and 100-db antenna isolation.

The dishes vary in size from about 10-in.-dia. (K_a-band) to 9-ft.-dia. (P-band).

The entire operational radar spectrum (plus an extension into the VHF radio band) is covered by the four radar systems. Feder says vertical and horizontal polarizations are provided for each, and radiated power can be varied by means of tunable attenuators.

Terrain-material specimens, loaded in 12 x 6 x 2-ft.-deep cars, will be rolled under the big arch on railroad tracks. Carrying up to 15 tons of material, the carts provide a surface area assuring complete enclosure of all but the P-band radar beam cross-sections at all aspect angles from 30-90°. A two-ft. cart depth, Feder pointed out, represents maximum C-band penetration in nearly-saturated soils.

Feder reports that two technical breakthroughs were accomplished in building the WESTAR facility: reduction of a complete P-band radar to a laboratory system, and the capability of making actual C-band laboratory-controlled measurements.

Only 13 months were required from concept to initial operation of the test facility.

In the upcoming terrain-sample tests, TI will collect radar signatures obtained as functions of signal amplitudes over the varying range of aspect angles from normal to grazing incidence. Hopefully, the test results will provide a series of curves of dynamic ranges which in fact should be identifying signatures of a variety of soil



ANECHOIC ARCH built by TI for Army will be used to identify terrain characteristics. Paired antennas (top to bottom) are for P-, X-, K_a, and C-band radars.

specimens and conditions.

In the next few months, specimens with increasing water content will be measured. Later, density and temperature will be varied in an orderly manner.

● **Possible lunar studies**—A theoretical study based on radar terrain analysis similar to the Army project will be performed by TI for Cambridge Research Labs. This is the second of two contracts now totalling about $80,000.

Directed by Dr. J. Van Lopik, the earlier paper studies made use of extreme-value estimates of lunar atmospheric factors (e.g., electron and molecular density) in an attempt to determine radar propagation effects.

However, TI's concurrent project proved the feasibility of such radar/terrain re-radiation analysis. It was deemed advisable to perform the new study to catalog radar signatures of postulated lunar surface materials.

Under the new contract, TI will design a program for radar lunar simulation studies. This will entail selection of materials and the broadcast conditions to read such specimens. Early studies showed that only a relatively small number of different materials need be investigated.

Early last March, TI announced it had received a NASA contract valued at $34,000 for a study to determine the need and feasibility of recording lunar gravity information.

This project, also directed by Van Lopik, is an extension of a current TI-funded R&D effort to determine the ability of gravimeters to withstand the impact shock of a lunar landing. Also, researchers had been trying to determine how gravity data might be employed to complement other lunar geophysical data that NASA has proposed to collect.

● **Radar promising**—If the results of current projects support theoretical predictions, Feder told M/R, radar could provide a very powerful technique for lunar exploration.

Infrared techniques are temperature-limited, while optical and photographic techniques are limited by illumination. But radar, said Feder, can penetrate the lunar surface; its echos will be varied as a function of the reflecting material. Furthermore, radar should be particularly advantageous against such a dehydrated surface as envisioned on the Moon.

It is conceivable, Feder told M/R, that P-band radar, based on current tests results with WESTAR, might permit depth readings of over 15 meters below the lunar surface.

The data from a single satellite-borne radar probe about the Moon, correlated with one or more successful *Surveyor* soil samplings, could provide a fairly extensive determination of lunar-surface characteristics, Feder predicted.

Radar antennas on such a lunar probe could sweep the surface in a manner much like that of a side-looking radar. A spin-stabilized vehicle could be employed to effect the necessary scan.

A highly directional pencil beam would be required.

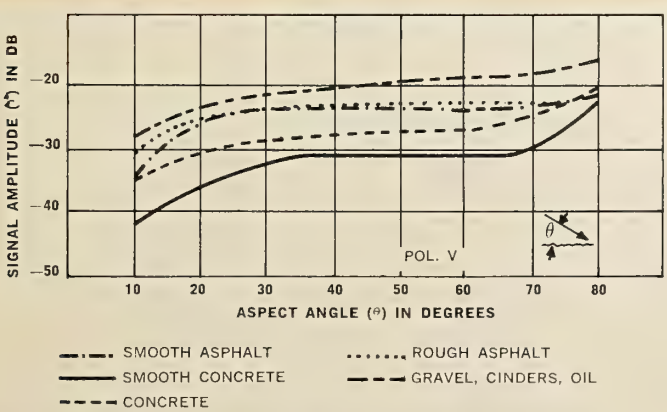
Altitude, said Feder, may create the biggest problem. Due to the relatively high lunar relief, radar measurements might have to be correlated with continuous altitude ranging to produce meaningful data.

● **Penetrometers suggested**—Another approach to radar surface inspection from an orbital vehicle may be the deployment of penetrometers, the TI scientist said. These might be very useful for determining surface bearing strength prior to manned-vehicle landings.

Developed by TI for the Army as an inexpensive but reliable method for examining terrain from aircraft, the patented devices have been designed in two basic types.

One employs a hollow metal tube having a heavy separate steel point on the impact end and stabilizing fins on the aft end. If the terrain is soft, the tube simply burrows in. If the ground is hard, a sheer pin securing the point in the tube end breaks, permitting the point to ram a plunger within the tube. In turn, the plunger punctures a standard CO_2 cartridge, inflating a radar-reflective balloon from the aft end of the tube.

The other penetrometer type is considerably simpler, consisting only of a heavy conical impact point and a fully vaned square shaft. The metal shaft serves as an omnidirectional radar corner reflector. Salvos are deployed from a fixed altitude sequentially, each having greater weight. Penetration thus is a function of the mass of the penetrometers. ■



CONTRAST of signal amplitude for various smooth surfaces at X-band.



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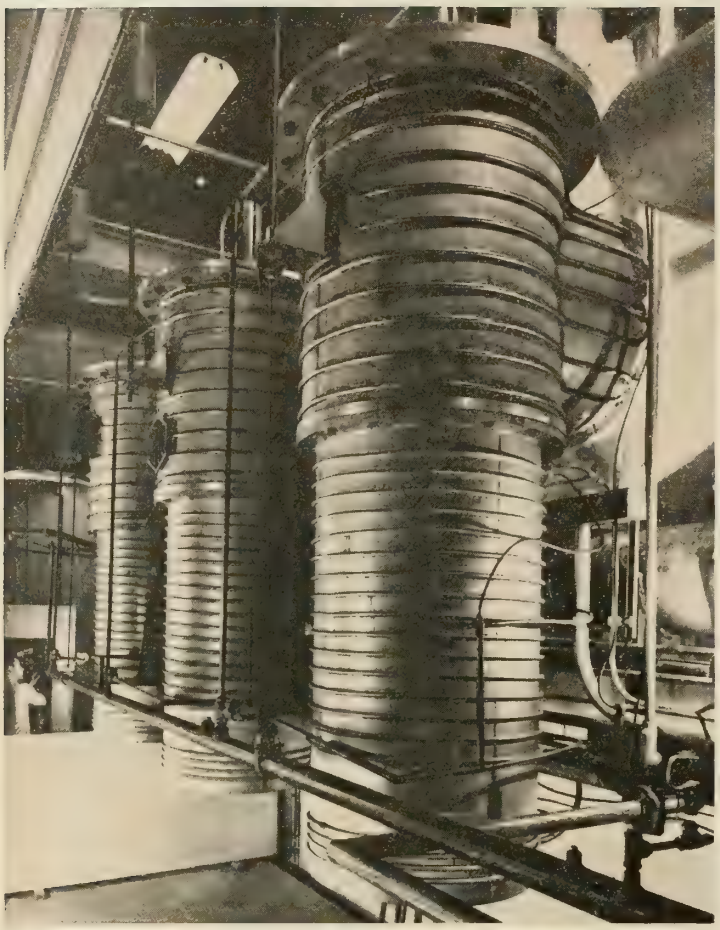
To this immense task, Lockheed has directed the nation's best qualified scientific staff. Experience? Working closely with the Air Force's Space Systems Division, they designed and built the USAF satellite tracking center at Sunnyvale, California, which has commanded, controlled, and processed data from more than three-fourths of all the satellites put into orbit around the earth. They are now laying the groundwork for the interplanetary Command & Control system that must become a reality in the '70's.

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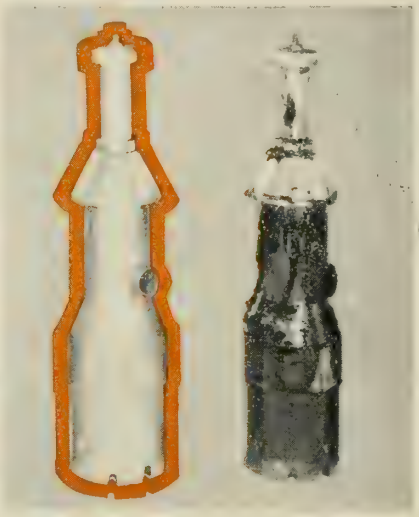


Six of these giant 32-inch diffusion pumps evacuate the 3,000 cubic foot, high altitude-temperature space chamber at the new Space Environments Laboratory of Fairchild Camera and Instrument Corporation's Defense Products Division, Syosset, New York. Designed for testing vehicles, systems and sensors in environments simulating altitudes up to 380 miles, at temperatures from —100 to 300 F, this ultrahigh vacuum chamber has achieved a pressure of 4×10^{-9} mm Hg. Dow Corning Diffusion Pump Fluid was chosen to achieve the ultrahigh vacuum required in this system.

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Value Engineering Progress Lacking

Critics put most of the blame on Defense Dept. failure to put real pressure on industry; new ASPR awaited

by Willard E. Wilks

INDUSTRY value engineers—sharply critical of the value engineering (VE) effort to date—are waiting to see whether revision of the Armed Services Procurement Regulations specifying details of VE clauses in incentive contracts will bring the reform they seek in industry.

They complain that the widely publicized VE effort has remained hardly more than "ballyhoo" and "window dressing" in a large segment of industry—despite Defense Department endorsement and the organizations, publications and training programs devoted to VE. And they charge that while DOD has demanded VE in contracts—and in some cases provided funds to set up VE efforts—much of industry management has not yet been prodded into sincere and vigorous action. As a result, say VE leaders, the VE concept has not been fully accepted and practiced by design engineers and others on the operational level. And they blame DOD for this more than industry.

Many VE executives feel that management has not been completely sold on VE because it won't take the time to understand. "Management can't spare the time unless there is some incentive involved. But it *will* take the time to understand profit; so the best way to get this done is to give industry a fair share of VE savings in all contracts, with hard and fast ground rules."

The value control manager at a large West Coast plant declares that DOD might as well stop awarding extra contract funds to set up VE programs, because the money is wasted. "Top management has accepted VE to the point of letting it exist, especially when the customer is paying for it, but not to the point of actually pushing it," he says. "A lot of companies are lukewarm or stone cold to it. They use it as window dressing and set up a 'front' so they can brief the customer when he comes around," the spokesman said.

While value engineers believe the movement has sufficient merit to make progress without additional contract support, they fear that, without strong incentives and ground rules, five years may pass before the concept becomes standard practice on the operational level. "It took quality control seven years before it stood on its own," a VE program director noted.

Once management begins pushing VE vigorously, "then no design engineer is going to buck it," another spokesman said. This is the crux of a problem said to be plaguing VE efforts on the operational level—that of winning over designers and others who have a natural resistance to cost-cutting Sherlocks.

A senior design engineer for a billion-dollar defense contractor admitted this resistance. Nevertheless, he said he recently completed a company value control course and enthusiastically endorsed everything he had learned. "But the main thing is that now I know the company is really interested in cutting cost. Before, I didn't think it was." He explained that engineers previously had lost all interest in originating cost-cutting suggestions, because they were met with apathy and rebuff. But he recommended that designers be left to seek out VE help "when we want it—not have these guys barging in here attacking something we've been living with for three months."

● **VE function**—A Douglas Aircraft Co. representative says value engineers believe VE's biggest operational problem is: "Where do you hang it on your organizational tree so it will be respected and operate on a timely basis?"

To be most effective, VE must deliver its inputs early in the design phase. But designers complain that schedules cannot be met when too many people try to get into the act. Value engineers are sympathetic to this view. As H. P. Rowe, value control manager, Autonetics Division, North American Aviation, sees it, the way to make VE effective is to make it a line function—to educate the design engineer to do the VE job himself. "But unless we analyze his work, we don't know whether he considered VE or not," Rowe explains.

So the matter becomes a staff function as well, and value engineers believe the designer must accept the idea of having them check up on his work. A number of companies are trying to plug VE into the design review stage by putting a value engineer on the design review board.

Attempts to achieve early VE inputs are being made by North American's Rocketdyne Division, where Walter Bayne reports that VE teams have been established to work with designers in investigating various trade-offs affecting preliminary decisions. Designs are reviewed later on for possible "second-look" cost improvements.

● **VE vs. OA**—On the other side of the VE coin, critics doubt that supporters' gripes are all fully justified. The complaints, they suggest, stem in part from the frustration of VE zealots who have been rebuffed in attempts to take over positions of influence for which they are not qualified—and in which others already may be doing a good job.

Some critics say the caliber of value engineers in general cannot match that of the operations analyst. The chief engineer on a major missile program declared: "The operations analyst is usually the highest type of individual money can procure. He may hold a Ph.D., and he is that unusually gifted person who is qualified to make major trade-offs in the conceptual stage. I'm not sure the value engineer has this capability. When VE was first promoted, value engineers thought they should be right next to the

president on the organization chart. They had to back down when they were told they didn't have the capability to tell the president how to operate and the design engineer how to design."

Many critics belong to a vast "old school" in industry which regards VE as little more than a new name for old cost-cutting schemes. Sometimes these critics consider value engineers as lightweight "cultists" who only think they have stumbled onto something new. But most value engineers agree that VE is not wholly new—that it encompasses and systematizes some older concepts.

Yet others cite as "new" certain definitions of VE that might well have been phrased by an operations analyst in 1946.

● **"Second-look"**—Virgil Simonick, *Nike-Zeus* chief development engineer at Douglas Aircraft Co., subscribes wholeheartedly to VE concepts and reports that Douglas is putting them into practice. But he believes that many value engineers "seem to be unaware of programs in their own house to reduce cost. They are familiar with such mundane things as scrap elimination drives and suggestion boxes, but I'm not sure they know about the parametric studies we make in selecting actual design of a missile. They will take an existing hardware design, 'brainstorm' it and come up with another design at a lower cost. We call that 'second-looking.' You can save a lot of money with it, but that's only peanuts compared to what you save on the first look—which is what operations analysts have been doing for years, up at the level where dollars really count."

Herbert L. Karsch, director of operations support at Ford's Aeronutronic Div., is not one of VE's stronger critics, but he says VE at Aeronutronic is regarded as an extension of the discipline that Ford Motor Co. has practiced for years as a matter of survival in an extremely competitive industry.

Operations analysts tend to be tolerant of value engineers, and credit them with a legitimate function. They complain, however, that some of the companies that have publicized big VE savings are those who "had something to fix because they did a lousy job in the first place."

On the whole, a survey of VE in industry shows a lack of understanding and communication, as well as unfortunate infighting, between value engineers and their critics. Though many critics regard VE as no more than "second-look" analysis, it is being practiced as more than that. VE supporters note that at this early stage VE has had more experience (and publicity) with cost-cutting in the "make" phase than in the design area.

In the charges and countercharges, value engineers claim operations analysts and others are not always so concerned with economy as they should be —and, in cases where they are, "they haven't been communicating this to others." In turn, value engineers are accused of exaggerated claims regarding cost savings. Some of the accused admit this, scoring their own group for creating bad publicity. But they also criticize management for wanting "only dollars-and-cents results." Many companies now are aware of this pitfall, however, and are reluctant to issue dollar figures on VE savings. Rocketdyne estimates that it has realized savings of $600 for every man-hour of VE effort, but stresses these are "paper" savings; Aerojet-General reports major savings but prefers not to quote figures; and Autonetics spokesmen don't stress dollar savings "because others have fallen flat by overemphasizing estimated savings." ■

'We've Done Things We Thought Were Impossible'

ONE COMPANY PRESIDENT who has enthusiastically endorsed value engineering is J. H. Famme, of GD/Convair. Famme notes that his troubled division, which has had to make big cutbacks recently, has found that VE produced some "startling" results.

"We call it value control," says Famme, an executive who came up through the engineering ranks, "because we look at it as applying to more than just a product or design. We've used it to evaluate procedures and flow of paper as well, and we've done things we thought were impossible. We combined manufacturing control and material control. They had been separate, large departments for years. Now we have fewer people, and it's actually easier. They combine forms and use the same piece of paper."

Famme, who was in charge of value control as Convair's director of manufacturing research three years ago, believes many companies could eliminate much inefficiency by applying VC to all functions of the company. "Over the years, many departments spring up in a company because at a particular time it is necessary to have them. Then they grow and grow, and the company never stops to look and ask, 'Why is this going on?' Business changes, but the organization doesn't. A department can go on processing paper, blithely doing things like it has for years. You must ask not only 'What is it?' but 'Why do you do it this way?' It's surprising what you find out."

Famme feels so strongly that VE must have top management support, that he makes it a point to attend VE seminar openings in the plant "to let the guys know this has my backing."

● **Overdoing it**—Some VE organizations appear too big to Famme. "You can set up a department that costs more than you are going to save. We have just one man. He's the pile driver. He directs the program." In addition, Convair has 12 supervisors—one from each department—assigned to extra duty as part-time coordinators to help run the value control effort. "This saves setting up a whole new department, another empire that defeats its purpose," Famme believes.

H. P. Williams, value control manager reporting directly to Famme, believes the clamor for writing VE into incentive clauses stems in part from VE personnel who simply want to protect their jobs. "There are an awful lot of people in the field who may think they understand VE but don't know how to apply it. But they want to stay in it, so they think one way to job security is to put it into the contract. A company shouldn't assign just anyone to VE. It takes people with a lot of background."

Williams believes a frequent problem with VE seminars is that they are conducted in a carnival atmosphere. "Consequently, engineers get leery." He says that another problem, not fully recognized in industry, is that engineers, though they are trying to design to the lowest possible price, "have not been trained in creative thinking.

"Though it is a key technique, few colleges teach it. Massachusetts Institute of Technology was the first to start such a course, only eight years ago. Other schools are just starting. This means that most engineers with six years of experience have had no instruction in creative thinking. Such a course teaches people first to define a problem and then to come up with a lot of ideas on how to solve it. Some might be screwball ideas, but from them often come some of the best results."

Convair regards VE as a state of mind. The design engineer is trained in VE, then does the job himself.

"You monitor, but you don't need a group of specialists to do the job the designer should do in the first place," Williams says.

AF Will Have Special Needs in Gemini

Demands on pilots will be greater than in NASA missions; shielding will differ; standardized equipment is planned

by Heather M. David

BIOASTRONAUTICS support for the Air Force's *Gemini* capsule may be radically different from that used with the NASA version.

While NASA will use the vehicle as a demonstration for portions of the *Apollo* program, the Air Force will exploit it to determine the operator requirements for an operational military space vehicle.

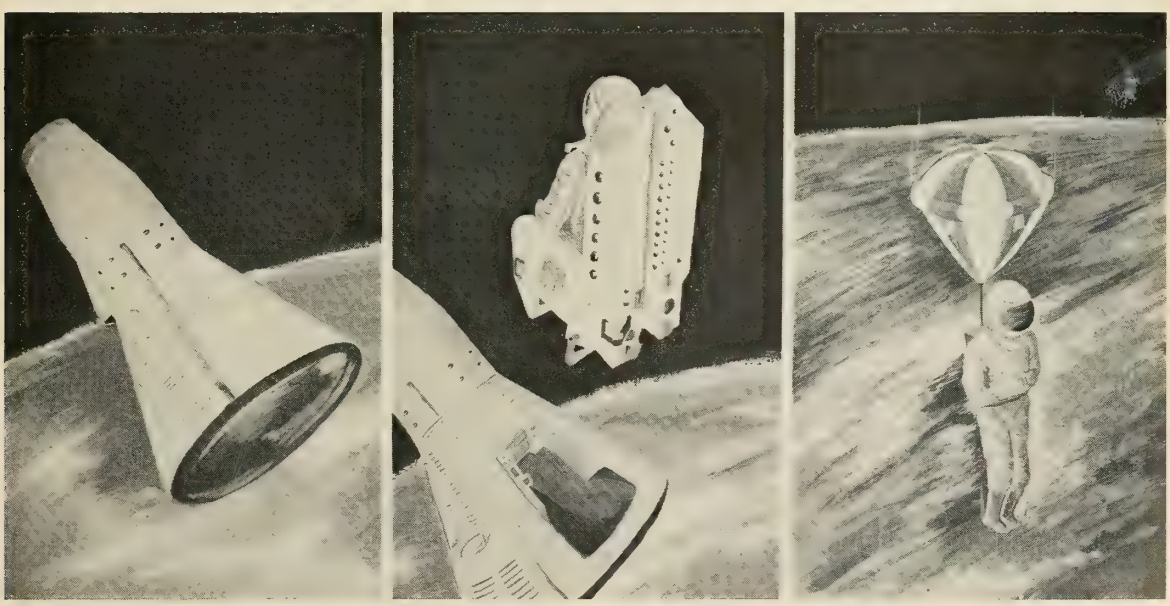
AF bioastronautics thus will have two roles in the *Gemini* program—supporting NASA in basic life support studies, training and selection, and developing a separate Air Force program.

Some of the discrepancies may be worked out in compromises as the *Gemini* program develops. However, there are these basic differences, in the view of AF bioastronautics experts:

Because the Air Force will be working toward an all-weather, quick-reacting space vehicle, the demands upon the pilot will be very great. Research will be needed on how man survives a mission in a space vehicle that is both launched and recovered in bad weather.

Radiation shielding criteria will also be different, since the vehicle will have to be capable of launching during a solar storm and may have to travel through the Van Allen belt.

Beside the additional physical stresses, there will be added psychological stresses. *X-15* experience has already shown that these pilots had much higher blood pressures as a normal condition during flight than did the *Mercury* astronauts. More must be learned



How 'Ballute' Might Save Project Gemini Astronauts

ARTIST'S CONCEPTION shows how Goodyear Aircraft Corp.'s Ballute drag device would operate as a safety measure built into Gemini crewman's ejection seat. If trouble should develop during first or final stage of flight, pilots could eject (center). After separation from their seats, the drag balloon would inflate a split second later and insure that the astronauts did not roll or pitch. Conventional parachutes could be used after crewmen reach lower altitude. Goodyear is incorporating the Ballute system into the ejection seat under a contract from Weber Aircraft Corp., Burbank, Calif.

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about what is normal to the highly active, performing pilot—and what his limits are.

If the Air Force decides to utilize the *Gemini* to its full extent, some of the backup systems may be removed for military equipment or booster power. This will put added burdens upon the pilot.

Simulation of combat conditions will greatly change the ground-air relationship. Ground monitors would be able to do little medical monitoring of the pilots in an operational situation. Instead, clinical-type instruments must be developed so that pilots can monitor their own conditions.

More in-flight treatment of injuries may be necessary in a military situation. The Air Force will be seeking to develop spaceflight first-aid methods.

● **Life support needs**—A major point of departure from NASA thinking is a reluctance among a number of Air Force space medicine experts to put the pilot in a 100% oxygen environment for any length of time. While 100% oxygen may be considered perfectly safe for a carefully monitored civilian mission, it may not be satisfactory for a military one.

Air Force bioastronautics experts point out that in recent NASA tests, subjects exposed to 100% oxygen plus accelerations had no atelectasis (collapse of air sacs in the lungs). However, the Royal Air Force has documented cases of atelectasis among pilots flying in cabins with 100% oxygen.

Even apart from physiological considerations, AF medics say, the fire hazard will make normal operating conditions impossible. The pilots will have to exercise extreme caution in heating meals, and they certainly will not be able to smoke.

Dyna-Soar is scheduled to have a two-gas (although separate) atmosphere because of the safety factor. The pilot will breathe oxygen, but the cabin will be pressurized with nitrogen.

● **Engineering changes**—Multiple-mission reliability would be required of the Air Force vehicle. Hence, the individual tailoring which has characterized much of the equipment belonging to the original astronauts will not be feasible.

Instead, the Air Force will look for standardized couches, helmets, suits and other equipment in a few sizes that will fit all its potential flying personnel.

● **Different tasks**—The Air Force says it will demand that its pilots go much further than NASA's in the control of the spacecraft. The military man may have to change orbits rapidly, rendezvous with hostile satellites, and perform other difficult navigational tasks. Much research will be conducted in ground laboratories to establish what man can be expected to do, and what computers and navigational aids should be furnished him.

Heavy emphasis will be put upon in-flight maintenance of military vehicles as well.

● **Extra-vehicular performance**—While NASA is contemplating egress of its astronauts, the military mission may require a quicker reaction time and more extensive and longer performance outside the vehicle. Contracts have already been negotiated for propulsion unit and prototype suit study.

● **Expansion**—New facilities at the Air Force's School of Aerospace Medicine at Brooks AFB, Tex., will permit almost a doubling of bioastronautics work there. The school has been authorized to bring its professional staff to almost 400.

New equipment, such as the dynamic escape simulator at Wright-Patterson AFB, Ohio, will aid in a stepped-up effort.

Although agreement on joint use of *Gemini* between the Air Force and NASA has not been signed, indications are that NASA will conduct its program, then leave the *Gemini* to the Air Force for its own experimentation. ■

Polaris A2 Parts Rejection Slashed

In-house tests by LMSC lower rate by 30%; Navy and contractor pressure put on suppliers; special system planned for A3 program

by Robert Lindsey

SUNNYVALE, CALIF.—Rejection of parts supplied for the *Polaris A2* missile has dropped 30% in the past eight months, thanks to an intensive program of in-house environmental testing by Lockheed Missiles & Space Co.

Meanwhile, LMSC is developing a comprehensive high-reliability program for *Polaris A3* components, aimed at minimizing part defects through a tight system of double checks between Lockheed and the supplier.

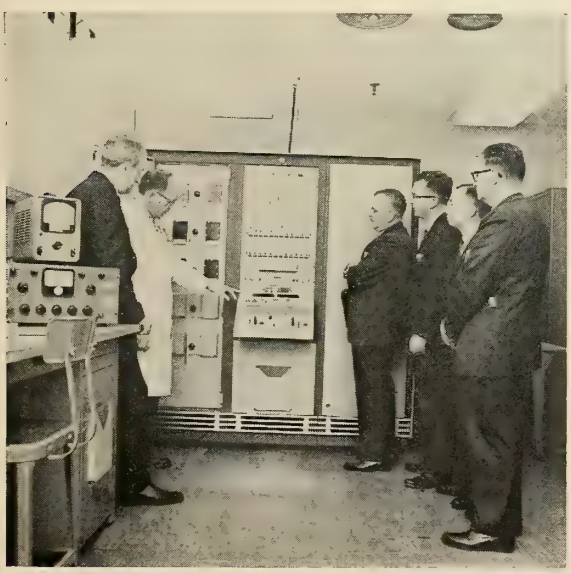
These two programs represent a determined effort by the Navy's Special Projects Office to assure reliability of the submarine-launched missile.

Rejects averaged 56% in the *A2* program when Lockheed began screenning parts from suppliers with a barrage of environmental tests simulating stresses of a *Polaris* flight.

Now, apparently, because suppliers realize that defective parts will be detected and rejected, quality has improved so that the rejection rate is 36% and still dropping, MISSILES AND ROCKETS has learned.

Some officials believe that the *A3* Hi-Rel Program, as it is called, and the Air Force's *Minuteman* reliability improvement program are symptoms of a far-reaching trend that may strongly affect the aerospace industry. They predict that all major aerospace projects ultimately will have programs aimed at reliability levels far beyond that tolerated today, and that the burden of proof will fall on the shoulders of industry.

● **PAT nudges**—"We're paying as high as triple normal prices for parts in *A3*. So we expect to get high quality and high reliability," says Wayne Kao, manager of Lockheed's Production Assessmen Test (PAT) Services, the organization monitoring quality of production parts for *Polaris*.



LMSC engineer S. F. Arnold (second from left) shows group of supplier representatives automatic semiconductor test system to be used to check transistors and diodes for A3 production vehicles.

LMSC recently hosted 102 representatives from the 43 companies supplying parts in the *A3* Hi-Rel program. At the meeting, officials explained the program and showed industry representatives the $1.4-million Lockheed facility where parts are screened before they are cleared for production lines.

One Lockheed engineer admitted that a principal reason for showing the facility to suppliers was to let them know "we mean business." And Kao noted that the PAT program is designed to firmly nudge suppliers to improve their manufacturing and quality control techniques—as well as to detect any determinental changes in the companies' manufacturing techniques or quality of material after they have qualified as sources of required production parts.

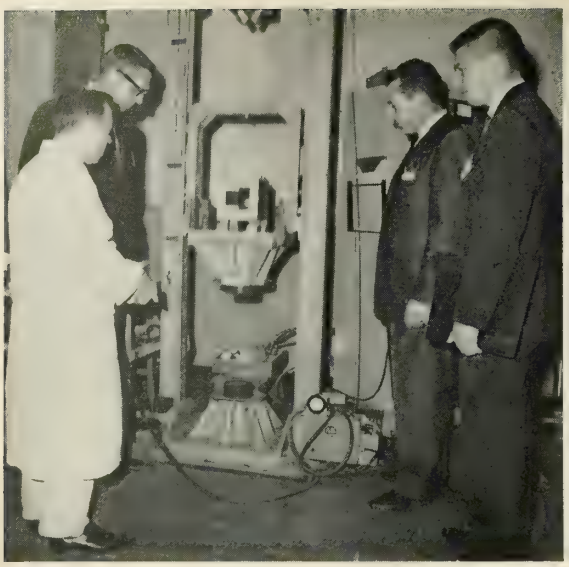
(Lockheed buys all avionic parts for *Polaris* from multiple sources; the Navy ruled out sole-source procurement early in the program.)

During production of the *A-1 Polaris*, conventional quality-assurance acceptance test techniques were used to screen parts from subcontractors. According to Kao, the screening procedures were adequate by normal standards; but they included no environmental tests.

In the spring of 1961, the Special Projects Office ordered a more stringent reliability screening plan for the *A2*.

The concept—adopted to meet the Navy's wishes—involved creation of a laboratory capable of in-house simulation of virtually all stresses encountered in a *Polaris* flight. First tests in the laboratory were under way by November, 1961; by July, 1962, the program was in full operation.

● **Lab details**—The laboratory covers 8,000 sq. ft. in the *Polaris* plant here. Its equipment includes: 3,000- and 5,000-force-pound vibration sys-



SERVO VALVES get jolt from shock tester for screening parts in Polaris A2. Photo was taken in Lockheed's Production Assessment Test laboratories during recent briefing for suppliers.

tems, each with dual heads and complete sine and random capabilities from 20 to 3,000 cps; 5,000- and 15,000-"G"-pound accelerators; several shock machines and many temperature and temperature-humidity chambers; automatic semiconductor test equipment; and other electronic test gear. An RPC 4000 computer is utilized for statistical analysis of test findings.

Currently the lab is working two shifts daily with a staff of 140, although this figure may increase when *A3* production begins to overlap production of *A2*.

This is how the *A2* Hi-Rel program works:

All incoming production parts for the missiles' hydraulic, interlock, umbilical assembly, and electronics packages are frozen upon arrival at the plant.

Navy plant representatives choose samples for testing from each lot at random—an average of 8½ % are selected. The balance of the lot is bonded and its release held up until after the PAT tests, which take about 15 days.

Transistors, diodes, capacitors, resistors, relays, transformers and connectors are the principal small parts tested.

Each component is subjected to four basic tests—temperature, shock, vibration and acceleration. In each case, the stress on the component is at the maximum level it might undergo in actual flight.

Parts are tested functionally before, during and after each environmental test, so that the time and environment of any degradation or failure can be pinpointed.

If a component malfunctions or fails, testing is halted immediately while a team of engineers and parts specialists convene to diagnose the failure. This is a key element of the program. A complete report is made on every malfunction and is given to the manufacturer so that possible random manufacturing errors and other problems can be identified and remedied, to ensure the quality of future parts.

This investigation ranges from visual inspection to full-scale dissection of a part to learn why it failed. Following the tests, detailed performance data are fed into the RPC 4000 computer and evaluated with advanced statistical techniques. If it is judged that a given lot does not meet required specifications, either the whole lot is returned to the supplier or it is screened to identify parts that do meet specifications.

If the statistical analysis indicates that the lot is satisfactory, the remaining parts in the lot are released for production, while parts that were tested are discarded.

To date, Kao estimated, Lockheed has completed tests on 275 different groups of parts for the *A2*—a total of 100,000 separate parts.

He said resistors and transistors have had the highest failure rates—exceeding 80% at one phase of the program. But because of the PAT efforts, causes of the failures have been detected and quality has improved. Though the program caused suspension of some suppliers initially, only one company was permanently disqualified, Kao said.

• **Production tests**—The PAT program does not end with the testing of parts; it includes tests of system assemblies pulled from production lines on a random basis, as well as the components of these systems.

System assembly and component tests are less severe than the parts testing, including only moderate environmental stress levels. The Navy chooses the system assemblies to be tested; initially, one in every 13 production-line assemblies was tested. This has been decreased to one in 16—and only one in 20 for the umbilical assembly, which has shown the least problems since early corrective action was taken.

For the A3 program, Kao said, manufacturers are being required to show in their own plants that their products meet performance and reliability levels.

The present PAT system will be discarded. "Since we are paying a premium price for the parts," say Kao, "we believe the suppliers will meet the high standards of the program, so we are substituting a new concept to check the Hi-Rel parts in house," Kao said.

"Suppliers will be required to carry out their own test programs by lot, and to supply LMSC with their data. We will then statistically correlate their test data with our own."

He explained that suppliers will conduct lot acceptance tests at their own plants and then provide their test results to Lockheed with each shipment. Lockheed, through the use of variables data obtained from their own testing of additional samples, will then verify the quality of the parts as well as validity of the supplier data.

The new program will have three phases: 1) acceptance of lot tests by the supplier; 2) validity check of supplier data—by Lockheed; and 3) reverification of supplier parts—by Lockheed.

All incoming shipments will be checked visually by LMSC, and the suppliers' test data will be checked to see if the parts meet specifications. A few samples from each shipment will be tested functionally to ensure that they are properly identified.

Meanwhile, Lockheed will have begun its own tests to check the validity of the suppliers' test data. It will work this way:

When the suppliers choose samples for their in-house lot acceptance tests, they must also choose other samples and mail them to Lockheed's PAT laboratory, where they will be tested environmentally. Any failure or malfunction will be investigated as to its cause.

LMSC test results will be compared with the results of the suppliers' tests of components in the same lot. A variables data analysis will be performed to determine whether the two sets of data are representative of the same lot and compatible with relevant statistical parameters.

If the analysis indicates that all parts in the lot meet specifications and confirms the validity of the suppliers' tests, the lot is approved. Any deviation in the findings will be investigated. ■

Welsh Sees Soviet Try At Docking This Year

NEW YORK—Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, has indicated that the U.S. is tracking at least the Earth-orbiting phase of the recent *Lunik IV* Soviet moon probe.

There is no evidence, he said, that a new, larger booster was used.

Welsh made these statements at a press conference and in a speech before a meeting of the American Institute of Aeronautics and Astronautics held here last week. In addition:

—He expressed belief that the USSR may attempt an actual space docking maneuver before the end of the year.

—He described as "quite possible" the prospect that the *Dyna-Soar* program could become a research-type project similar to the *X-15* (MISSILES AND ROCKETS, April 1, p. 45). Though he favors continuation of the program, he said he has "not heard anything particularly optimistic lately."

—He defended NASA's proposal for a Boston Electronics Research Center, now undergoing Congressional scrutiny. Noting that it is one program "bound to stick out" in the review, he said it should experience no difficulty if attention is focused on technical rather than political factors.

—Welsh made a strong plea for a military capability—"in space and against threats from space." This he said, is "as essential as preparedness in any of the other defense dimensions. We can't expect to wave a blueprint at a hostile spacecraft and scare it away."

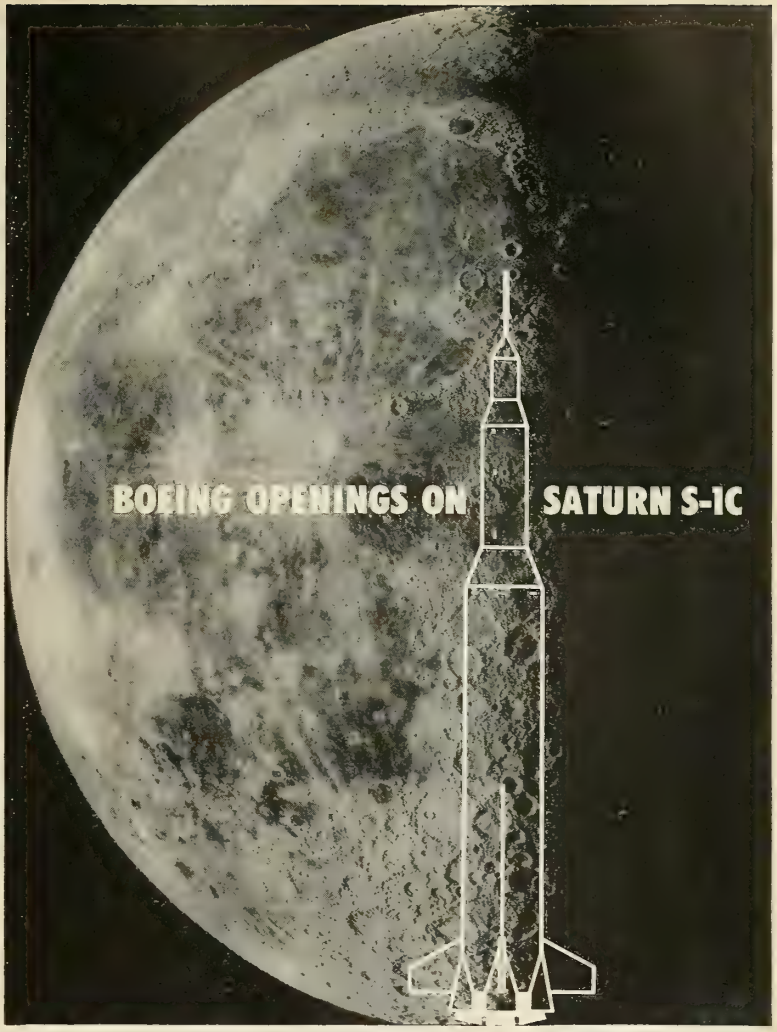
—He conceded that the Air Force might take over *Gemini* management.

—Commenting on *Apollo* costs, Welsh said latest estimates of overall project costs are "just under $20 billion"—about where they should be, he declared.

—Welsh predicted that efforts to prevent R&D overlapping between NASA and the Communications Satellite Corp. could lead to having NASA do advanced research while the ComSat Corp. handles research aimed at maintaining "what is up there." But he said his prime interest in the related functions of the two organizations concerns any area that both might fail to explore.

—He urged new emphasis on aerospace medicine: "The Russians are ahead of us [and] planned from the very start a very vigorous program in this area."

—And he defended the space-race to the Moon: "We can afford the space program," he said. "We must afford it. We can be satisfied with nothing less than first place to the Moon. . ." ■



Boeing has primary developmental, building and test responsibility for NASA's Saturn S-1C advanced first stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

This rapidly expanding program provides unique advancement advantages and ground-floor opportunities to physicists, mathematicians and engineers with the following specialties: structural design, electrical/electronics, propulsion, aeronautics, systems test, mechanical design, industrial, manufacturing, facilities, high vacuum, astrodynamics, cryogenics and thermodynamics.

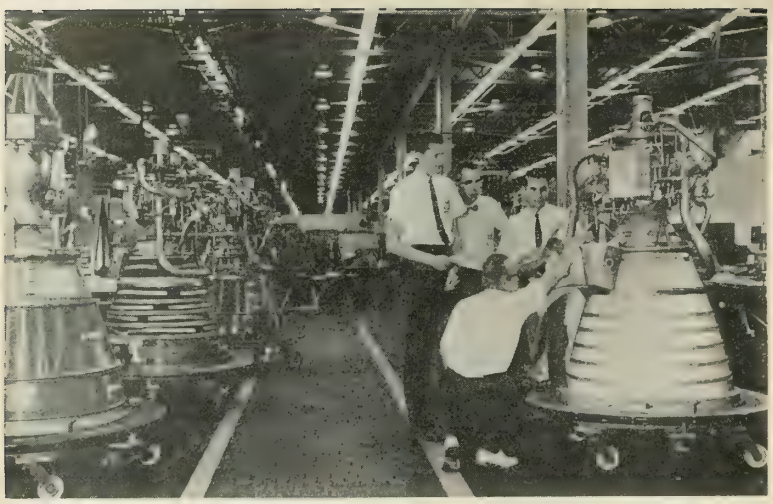
Salaries are commensurate with all levels of education and experience. Minimum requirement is a B.S. degree in any applicable scientific discipline. Boeing pays travel and moving allowances to newly-hired engineers.

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn, and other missile and space programs at Boeing – including the solid-fuel Minuteman ICBM and X-20 Dyna-Soar boost-glide vehicle – are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

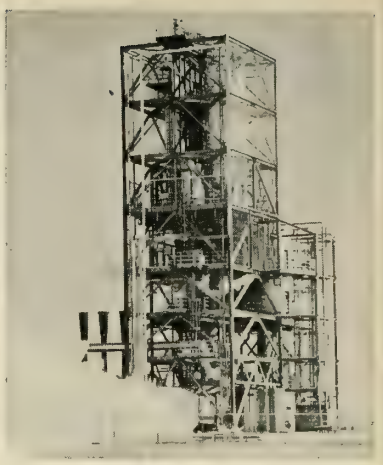
Send your resume to Mr. L. Wendell Hays, The Boeing Company, P. O. Box 26088-MSJ, New Orleans, La. An equal opportunity employer.

BOEING
AERO-SPACE DIVISION

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SEVERAL RL10 powerplants in various stages of completion are shown in the P&W assembly area. These units will power the Saturn S-IV stage and Centaur.



RL10 FIRED under simulated space conditions at P&W's test stand. More than 2500 firings have been achieved with the high-specific-impulse engine.

P&W Completes Liquid Test Complex

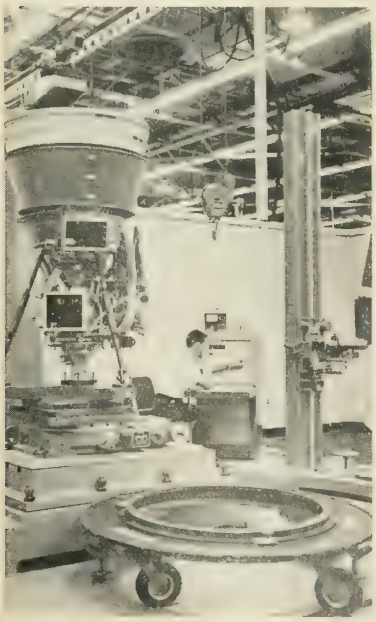
A MULTIMILLION-DOLLAR addition to Pratt & Whitney's Florida Research and Development Center, West Palm Beach, will be capable of handling all known combinations of liquid propellants—including fluorine, hydrazine, diborane and hydrogen.

The addition, now under construction, will have three firing bays handling thrust levels of 1000, 10,000 and 50,000 lbs. The two higher-level bays will share a common propellant supply consisting of high-pressure fuel, oxidizer and additive tanks. The 1000-lb. thrust bay has both high- and low-pressure supply tanks.

The common high-pressure capability allows research on engines with thrust chamber pressures of more than 3000 psi. The facility can handle either cryogenic or storable propellants through a range of pressures from 300 to 5000 psi.

The addition completes the existing cryogenic rocket test complex and will be used for further development and test of the P&W RL10 liquid hydrogen engine—the powerplant slated for both the *Saturn* S-IV stage and the *Centaur* upper-stage vehicle.

The 7000-acre site at the edge of the Everglades already has figured in some of United Aircraft's planning for future work in large solid rocket development. UAC's big solid effort is currently located at United Technology Center in California. The projected work in Florida probably would involve vehicles larger than the 120-in. *Titan III-C* strap-on boosters.





LEFT: *One of many tests applied to the RL10 liquid-hydrogen engine during its assembly and checkout at West Palm Beach facility.* **ABOVE:** *Artist's conception shows new addition to the P&W Florida R&D Center, scheduled for completion in the fall. All known propellant combinations can be handled here.*

Mergers & Reorganizations

Marquardt Corp. has begun what it calls "serious negotiations" with Curtiss-Wright Corp. in an effort to acquire C-W's Electronics Div. No facilities would be involved in such a transaction, and precisely what assets the deal will involve are as yet undermined.

Though C-W admits that the negotiations are scheduled, it will provide no details. But Marquardt president Roy E. Marquardt predicted that some particulars would be at hand within three months.

The C-W Electronics Div. produces simulation systems with defense, aviation and missile/space applications. Marquardt has extensive experience in advanced data display systems that could tie in with such a line of simulators.

Also, MISSILES AND ROCKETS has learned that a team of Marquardt engineers has spent several months touring various military bases, studying military-type simulators with a variety of applications, ranging from pilot training to electronic countermeasures. . . . *Teledyne, Inc., Hawthorne, Calif., has acquired the privately owned Aerial Control Geotronics, Monterey Park, Calif. The deal involves exchange of stock. Teledyne, which reported 1962 sales of more than $10 million—more than double 1961 sales—has made six acquisitions in the past 2½ years.* . . . International Electronic Research Corp. shareholders have approved proposed acquisition of the Burbank, Calif., firm by the Dynamics Corp. of America. All assets of IERC will be exchanged for 331,700 shares of common and 100,000 shares of preferred DCA stock, and IERC will become a wholly owned subsidiary of the New York based DCA. . . . *Union Carbide Corp.'s Haynes Stellite Co., Kokomo, Ind., has been renamed Union Carbide Stellite Co. Nothing will change but the name, officials said, and even product trade names derived from the original Haynes title will continue to be used.* . . . Westinghouse Electric Corp.'s Semiconductor Div. at Youngwood, Pa., has been reorganized along product lines. The five new product departments formed in the shift are: Rectifier Products; Transistor and Controlled Rectifier; Volume Products; and Special Products.

Talk Is Cheap?

Raytheon Co., which has conducted a personnel study that backs up its contention, maintains that the typical $10,000-per-year executive does $250 worth of talking each month. The firm has installed mobile radios in its executives' automobiles to facilitate communication with home offices while the officials are enroute between any of Raytheon's 26 Massachusetts plants and laboratories.

The company says its survey shows, however, that an average executive at least listens more than he talks. Communication time for these officials breaks down like this: writing—9%; reading—16%; talking—30%; and listening—35%.

Though the study did not indicate to whom these executives spent the bulk of their time listening, one company source suggested that "executives higher up the line are probably the speakers at such times."

SPSE Offers Papers on Space

The Annual Conference of the Society of Photographic Scientists and Engineers, planned for Atlantic City April 29 through May 3, will have two sessions devoted to topics of interest to the missile/space industry.

Both sessions will be held on the first day of the conference—one in the morning, the other in the afternoon—and both are entitled "Satellite and Missile Photography." Speakers will include representatives of government and industry—among them: F. C. Thompson, Philco; E. C. Cheadle and R. M. Jefferson, Monteck, Inc.; L. O. Hayden, Naval Research Laboratory; F. T. Gronberg, Edgerton, Germeshausen and Grier; P. B. Swenson, USAF Cambridge Research Laboratories; G. C. Weiffenbach, Johns Hopkins Applied Physics Laboratories; and W. Markowitz, U. S. Naval Observatory.

Topics to be covered in the papers include: memory and timing systems and image orthicon system related to the *ANNA* geodetic satellite; a discussion of the photographic observations of *ANNA;* visual magnitude of a passive, cylindrical Earth-oriented satellite; optical calibration of the U. S. Naval Space Surveillance System; and an image-intercept tracking system.

Among other highlights of the SPSE Conference—this year co-sponsored by the Army Research Office—will be sessions on aerial reconnaissance, photographic equipment and data recording, image evaluation and sensitometry, and photographic theory.

Cape-To-California Jets Set

Industry and government personnel are being advised of a new jet service designed by National Air Lines to improve Cape-to-California commuting.

Beginning April 28, NAL will offer two jet flights per day, one eastward, the other westward bound. The eastward flight will be routed from Los Angeles to Melbourne, Fla., with one stop in Houston. The flight to the West will originate at Miami and stop at Melbourne, Houston and New Orleans, terminating at Los Angeles.

Recent modification of Melbourne Municipal Airport, nearly doubling runway length, made the new jet service possible, officials said.

contracts and procurements

AWARDS

AIR FORCE

$17,344,000—**Martin Marietta Corp.,** Littleton, Colo., for continued research and development on *Titan II* missile.

$15,000,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for production of *Minuteman* guidance and control systems.

$10,400,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for research and development and production of *Agena* space vehicles.

$9,000,000—**Boeing Co.,** Seattle, for *Minuteman* missiles.

$8,000,000—**General Electric Co.,** Syracuse, N. Y., for weapon control systems.

$6,100,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued production of *Minuteman* second-stage engines.

$5,000,000—**North American Aviation, Inc., Autonetics Div.,** Anaheim, Calif., for research and development on advanced *Minuteman* missile guidance systems.

$4,800,000—**General Dynamics Corp.,** San Diego, Calif., for operation of a test facility at San Diego.

$3,800,000—**International Business Machines, Inc.,** Rockville, Md., for electronic data processing programs.

$3,600,000—**Systems Development Corp.,** Santa Monica, Calif., for development of a systems training program.

$2,600,000—**Martin Marietta Corp.,** Baltimore, for continued work on *Titan* missile base in Colorado.

$2,400,000—**Lockheed Aircraft Co.,** Sunnyvale, Calif., for work on space systems.

$2,200,000—**Philco Corp.,** Palo Alto, Calif., for continued work on space programs.

$2,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for continued work on the *Titan II* propulsion system.

$2,000,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on space vehicles.

$1,700,000—**General Electric Co.,** Evendale, Ohio, for design and development of a lift-engine demonstrator.

$1,500,000—**Western Electric Co.,** New York City, for BMEWS communication system.

$1,200,000—**Lear Siegler, Inc.,** Grand Rapids, Mich., for continued production of gyroscopes.

$1,200,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for continued production of *Minuteman* first-stage motors.

$1,000,000—**North American Aviation, Inc.,** El Segundo, Calif., for production of *Minuteman* guidance and control systems (supplemental contract). Work to be done in Anaheim, Calif.

ARMY

$7,800,000—**Ets-Hokin and Galvan, Inc.,** San Francisco, for construction of mission control center at NASA's Manned Spacecraft Center, Houston.

$7,302,260—**Western Electric Co.,** New York City, for research and development on the new *Sprint* high-acceleration antimissile missile. Work to be done at Orlando, Fla., and Whippany, N. J.

$5,500,000—**Thiokol Chemical Corp.,** Marshall, Tex., for *Sergeant* missile motor production.

$5,000,000—**Aerojet-General Corp.,** Sacramento, Calif., for production of a drone system.

$4,400,000—**Aerojet-General Corp.,** Sacramento, Calif., for production of *Hawk* missile rocket motors.

$4,100,000—**Firestone Tire and Rubber Co.,** Akron, Ohio, for classified work.

$2,300,000—**Mason & Hanger-Silas Mason Co.,** Burlington, Iowa, for production of warheads for *Nike-Hercules* and *Hawk* missiles.

$2,200,000—**Holston Defense Corp.,** Kingsport, Tenn., for propellant production.

$1,900,000—**Collins Radio Co.,** Cedar Rapids, Iowa, for *Sergeant* missile fuses production.

$1,100,000—**Minneapolis-Honeywell Regulator Co.,** Hopkins, Minn., for work on *Sergeant* missile.

$1,000,000—**Philco Corp.,** Philadelphia, for production of *Sergeant* missile fuses.

$500,000—**Sperry Rand Corp., Sperry Utah Co. Div.,** Salt Lake City, Utah, for *Sergeant* missile and ground associated equipment.

$140,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for *Nike* missile system components.

NAVY

$160,300,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for continued research and development on the *Polaris A3* IRBM.

$19,800,000—**Thiokol Chemical Corp., Reaction Motors Div.,** Bristol, Pa., for rocket engine production.

$7,000,000—**General Electric Co.,** Washington, D. C., for *Polaris* missile gimbal assemblies.

$6,900,000—**Bendix Corp.,** Mishawaka, Ind., division, for production of the *Talos* missile system.

$5,700,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for *Polaris* missile production.

$4,500,000—**Goodyear Aircraft Corp.,** Akron Ohio, for *Subroc* missiles production.

$3,000,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, for *Polaris* missile gimbal assemblies.

$1,600,000—**American Machine and Foundry Co.,** Greenwich, Conn., for *Bullpup* missile rocket motors.

$1,400,000—**General Mills, Inc., Electronics Div.,** Minneapolis, for *Asroc* missile assembly components.

$850,000—**Sperry Gyroscope Co., Air Armament Div.,** Great Neck, N. Y., for MK2 *Polaris* FBM guidance system inertial components.

$756,450—**Vitro Corp. of American, Vitro Laboratories Div.,** Silver Spring, Md., for design and fabrication of specialized electronic equipment, for expansion of *Tartar* missile systems engineering work, and for tactical operations analysis (3 contracts).

$700,000—**Hycon Manufacturing Co.,** Monrovia, Calif., for *Terrier* and *Tartar* missile test sets.

$300,000—**General Dynamics Corp.,** Pomona, Calif., Div., for *Tartar* and *Terrier* missile components.

$195,600—**Grumman Aircraft Engineering Co.,** Bethpage, N. Y., for search radar antenna.

$54,000—**Value Engineering Co.,** Alexandria, Va., for engineering services connected with *Bullpup* missile engines.

NASA

$6,500,000—**Lear Siegler, Inc.,** Anaheim, Calif., for design and production of electronic systems for Marshall Space Flight Center, Huntsville, Ala.

$96,000—**Operations Research, Inc.,** Silver Spring, Md., for advanced study of the *Nimbus* meteorological satellite system.

$60,000—**Systems Engineering Laboratories, Inc.,** Fort Lauderdale, Fla., for 150 new-type operational amplifiers to be used in equipment for simulating space vehicle guidance systems at Marshall Space Flight Center, Huntsville, Ala.

General Motors Corp., Allison Div., Indianapolis, for building *Apollo* spacecraft's Service Module's fuel and oxidizer tanks (undisclosed amount).

Airite Products, Inc., Los Angeles, for production of the *Apollo* spacecraft's tanks to contain helium needed to pressurize the fuel and oxidizer tanks (undisclosed amount).

INDUSTRY

$55,000,000—**Melpar, Inc.,** Falls Church, Va., from **North American Aviation's Autonetics Div.,** for *Minuteman* high-reliability circuit boards.

$3,000,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, from **General Dynamics Corp.,** for *Centaur* vehicle guidance system work. Work to be done at St. Petersburg, Fla.

Martin Co., Orlando, Fla., from **Bell Telephone Laboratories,** for work on the *Sprint* missile (undisclosed amount).

Thompson Ramo Wooldridge, Inc., TAPCO Div., Cleveland, from **United Technology Corp.,** for development and fabrication of nozzles for the first-stage booster rockets of the *Titan III-C* space launch vehicle (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

U. S. Army Missile Command
Redstone Arsenal, Ala.

Pershing repair parts. Tool Industries of Florida, Inc., has been selected without competition because existing documentation is not adequate for competitive procurement. Tool Industries is the only known source with the technical knowledge and facilities capable of delivering the items within the required time. This synopsis is to publicize subcontracting opportunities, and all inquiries must be referred to Tool Industries of Florida, Inc., 1691 Wingate Road, Fort Lauderdale, Fla.

General Support Div.
Directorate of Procurement and Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure additional engineering services relative to the Type II (Model 1025) target missile system. This synopsis is to publicize possible subcontracting opportunities, and all inquiries relative to subcontracting must be referred to Beech Aircraft Corp., Wichita, Kan.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with the Rosemount Engineering Co., Minneapolis, Minn., for multi-sensor system—5 each. Sensors—50 each. Probes calibrated—8 each. RFP C-86555. Note: For information only, RFP not available.

Negotiations will be conducted with Rembar Sales Co., Dobbs Ferry, N. Y., for tungsten sheet and rod of different sizes—lot. RFP C-74670. Note: For information only, RFP not available.

National Aeronautics and Space Administration
Procurement Branch
Washington 25, D. C.

NASA is negotiating a contract with Advanced Systems Development Div., International Business Machines Corp., Yorktown Heights, N. Y., for implementation, test and evaluation of a selective dissemination system for NASA scientific and technical information. This action is the result of an unsolicited proposal. This notice is for information only.

Secondary Items Branch
Procurement Div.
Procurement & Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

Fairing, rocket motor. Federal Stock No. 1340-777-5206. Ord. Part No. 10049045—444 each. IFB AMC(Z)-01-021-63-575B. Bid opening 5-2-63. Drawings, specs and bid sets available from nearest procurement district.

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with Thermal Dynamics Corp. for a plasma torch system and accessories. RFP C-95309. Note: For information only, no RFP available.

National Aeronautics and Space Administration
Headquarters—Procurement Branch, Section C
801 19th Street, N. W.
Washington, D. C.

NASA contemplates negotiating the extension of a contract with Excelco Developments, Inc., Silver Creek, N. Y., based on the proposal to continue large solid-propellant motor fabrication studies. This notice is for information only.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Air-bearing table data system—Item—IFB S-2226. Bid opening 4-15-63. Bid sets are available. Miss Ruby Russell, Bid Officer, 4809 Lawrence St., Hyattsville, Md. Code 242.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Design, furnish and construct a spherical rocket motor test enclosure consisting of a test cell and control building in accordance with NASA specs and drawings listed therein. Job—IFB L-3166. Bid opening 4-26-63.

Direct Support (Guided) Div.
Directorate of Procurement and Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

This is not a request for proposals. The synopsis covers procurement of advance production engineering effort for the *Shillelagh* missile subsystem consisting of product evaluation data analysis, studies and tests; tooling and facilities requirements studies; plant layout; reliability; standardization; value engineering and quality control data analysis, studies and tests, and documentary reports of such effort. Period of performance is approximately 14 months. Specs as to type, kind and completeness, stating necessary qualitative requirement, are neither adequate nor feasible to be prepared to support competitive procurement. All inquiries relative to subcontracting opportunities must be referred to Aeronutronic Div., Ford Motor Co., Newport Beach, Calif.

National Aeronautics and Space Administration
Procurement Office
Marshall Space Flight Center
Huntsville, Ala.

Development of stress-relief treatments for high-strength aluminum alloys. Job—RFP TP-3-85371. RFP due date 4-22-63.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

Negotiations will be conducted with Somyc, Inc., 870 Smithfield Ave., Lincoln, R. I., for additional netting type body supports—RFP MSC-63-492P. Note: For information only, no RFP available.

Negotiations will be conducted with North American Aviation, Inc., Space and Information Systems Div., 12214 Lakewood Blvd., Downey, Calif., for study of a six-man modified *Apollo*-type spacecraft for logistics and operational support of a manned orbital space station. RFP MSC-63-477P. Note: For information only, no RFP available.

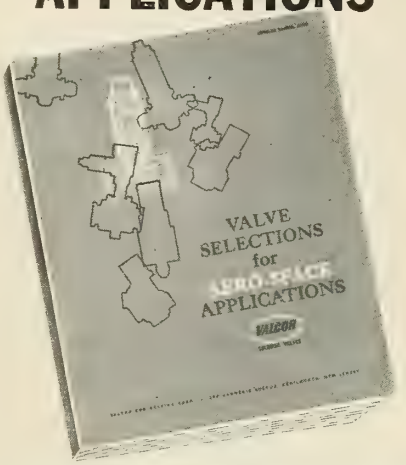
Purchasing and Contracting Officer
U. S. Army Missile Support Command
U. S. Army Missile Command
Redstone Arsenal, Ala.

Forty line items of long leadtime chassis type items of repair parts for NATO "D" production run of high-power illuminator. Delivery requested by Oct. 63. Duplication of initial investment, special tooling and facilities plus the nonavailability of drawings and specs adequate to support competitive procurement precludes award to other than the prime contractor, Raytheon Co., Willow St., Waltham, Mass. All inquiries relative to subcontracting must be referred to Raytheon Co.

National Aeronautics and Space Administration
Headquarters—Procurement Branch, Section C
801 19th St., N. W.
Washington, D. C.

Contemplates negotiating a contract with the General Electric Co., Defense Systems Dept., Santa Barbara, Calif., on the basis of their proposal to continue engineering evaluation and planning for large solid-propellant stages. This notice is for information only.

VALVE SELECTIONS FOR AERO-SPACE APPLICATIONS



A Comprehensive Handbook for users of Aero-space Solenoid Valves!

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Advertising Closing Date: April 29
Issue Date: May 20

On May 20, MISSILES AND ROCKETS will publish its Special Electronic Report covering Test and Checkout equipment.

As the state-of-the-art advances, Test and Checkout equipment becomes even more important to future space successes. During the past year there have been dramatic advances in this area but much remains to be done by industry and government.

MISSILES AND ROCKETS, the Weekly of Space Systems Engineering, will provide in-depth reports on . . .

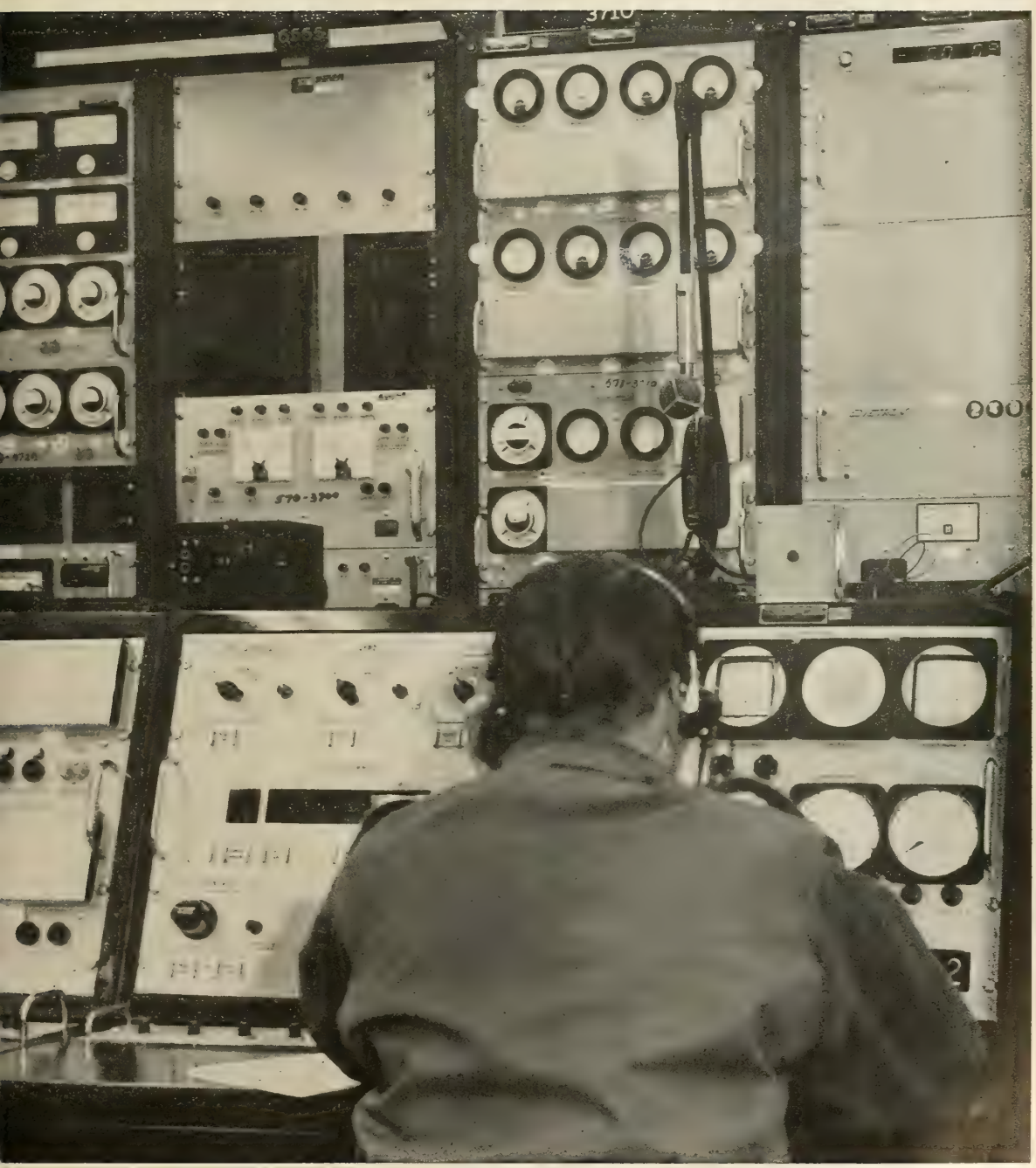
- The Test and Checkout Equipment Market, trends through 1970 for equipment research and development and procurement.
- Equipment requirements for Advanced Missile Checkout/Space Booster Checkout/Space Vehicle Checkout/In-flight Manned Spacecraft Checkout.
- Systems and Major Subsystems for Environmental Testing of Space Chambers/High Vacuum Equipment/Temperature/Pressure/Salinity/Radiation/Shock/Vibration.
- Integrated circuits, a special emphasis section.

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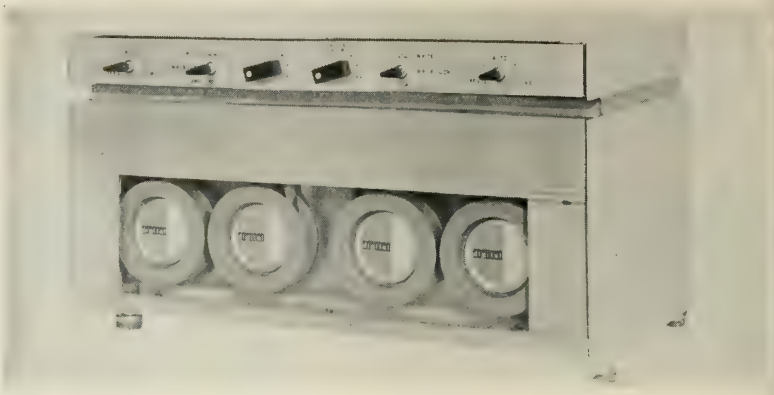
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products and processes



New Product of the Week:

Compact Magnetic Tape System

A COMPACT magnetic tape system has been developed by Digital Equipment Corp. Units of information as small as three binary bits can be replaced on the tape without disturbing adjacent information.

The features of Micro Tape 555's electrical design are phase recording and a permanent timing track. Read, write, and search speed is 80 in. per sec. Searching can be carried out in either direction.

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Microwave Power Supply

A single power supply capability said to be for all microwave tubes, has been developed by Paradynamics, Inc.

Model 801 utilizes plug-in modules and is specifically engineered to provide power and modulation for klystrons, backward-wave oscillators, traveling-wave tubes and voltage-turnable magnetrons.

Modules include: beam supply: 100-4200 v., 200 ma throughout, with 1.5 millivolts ripple, regulated to ±0.005%; anode supply: −450 to 450 v., 25 ma, 500 microvolts ripple, regulation to ±0.005%; three grid supplies in one package, providing 20-2000, 20-2000 and 200-2000 volts, 0-50 microamps, 0-50 microamps and 0-10 ma, respectively—all with 500 millivolts ripple, regulated to ±0.005%; and heater supply, continuously adjustable from 0-15 volts, 5 amps, 0.01% ripple, 0.1% regulation.

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Reaction Torque

An intertially balanced actuator, which imparts no reaction torque to a space vehicle while positioning an appendage, has been developed by Garrett-Airesearch.

Called "Zeract Drive" (zero reaction), the unit inherently balances all inertial and frictional forces, both internally in the actuator, as well as those externally to it.

Frictional forces are neutralized by counterbalancing and arranging internal components, such as gears, and effectively trapping internal forces within the power circuit. Applications for the unit include orientation of spacecraft antennas and solar array panels.

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Portable Test Set

A compact and portable instrument for aligning and maintaining transmission lines has been developed by Hewlett-Packard Co. The Model 3550A contains a wide-range oscillator, a voltmeter, and an attenuator with impedance-matching networks to match both oscillator and voltmeter to 135-, 600- and 900-ohm lines. These instruments are mounted in a combining case equipped with a splash-proof cover. The oscillator, voltmeter, and the attenuator with its impedance-matching transformer may be used separately either in or out of the combining case.

The oscillator has a range from 50 cps to 560 kc, with an amplitude variation within ±3%. The voltmeter has a 0.001 to 300 volt range from 5 cps to 2 mc. The attenuator provides 110 db of attenuation in 1-db steps.

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Voltage Dividers

Rotek Instrument Corp. is marketing a-c inductive volt boxes. Models ARS-501 (2.5f/1000v) and ARS-502 (11f/1000v) are high-voltage, multiple-fixed-ratio, wide-range inductive voltage dividers of ultimate accuracy; and they provide higher voltage operation, increased resolution, and increased accuracy at medium and high overall input-output ratios in conjunction with existing variable-voltage, inductive or resistive dividers. The units make possible precision a-c millivolt and microvolt sources at extremely low output impedance.

Features include: no switches; all fixed ratios; 1000v upper limit; full 30-5000 cycle range; ½-part/million accuracy.

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Test Chamber

Associated Testing Laboratories, Inc. is marketing Bantam Econ-O-Rack test chamber.

The Model RLHU-0.5-LC is designed to meet the requirements of temperature testing for bench-top operation, as well as for standard 19-in. relay rack mounting, and uses the highly sensitive and reliable Universal Electric indicating controller.

The unit features: internal working dimensions of 12½-in. by 7½-in. by 11-in. of Series 304 stainless steel and a temperature range of —100° to +425° F with forced air circulation and rapid pull-down time.

Circle No. 230 on Subscriber Service Card

Portable Oscilloscope

Dual-trace capability—in a portable, all-transistorized, all-militarized oscilloscope—is offered by the Electronic Tube and Instrument Division of General Atronics Corp.

The DT-106, the transistorized dual trace plug-in vertical amplifier is interchangeable with the high gain single channel plug-in which is standard equipment with the K-106. No instrument modifications is required to use the plug-in.

The bandwidth of the dual trace plug-in gives the 18-pound mil-rugged K-106 6 megacycle bandwidth presentation of all signals.

Features of the DT106 include single or differential presentation of phenomena and chopped or alternate presentation of two electrical phenomena simultaneously through high frequency switching of approximately 100 KC.

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Light Emitting Diodes

A type of laser in which light is generated directly by passing an electric current through a semiconductor crystal is being marketed by General Electric's Research Laboratory.

G.E.'s initial research samples are housed in a transistor package with a window in the top capable of passing infra-red light.

Both type LED-1, the non-coherent light source, and type LED-2, the coherent light source, can be furnished bound in a package with a removable cap, so that they may be incorporated directly into an optical system.

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Voltage Unit

Carl Zeiss, Inc., offers high-voltage unit Type HA 300, providing stable direct voltages from 50 to 300 kv from standard a-c electrical outlets.

The HA 300 is designed for use in operation of ion sources, testing dielectric strength of insulation materials and in such industrial processes as electron-beam welding.

The instrument operates on the HF cascade principle. It consists of a power supply unit and a self-excited oscillator (about 40 kilocycles) which feeds a multi-stage dry-rectifier cascade. Use of dry rectifiers gives high spark-over strength and long life, Zeiss says.

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Portable TV Tape Recorder

A portable television tape recorder —weighing 68 lbs. and capable of recording on one-inch tape a 3.5 megacycle bandwidth from any image-orthicon or vidicon camera—has been developed by Precision Instrument Co.

The fully transistorized device, which records both audio and video at only 7½ ips, enhances the usefulness of many military and aerospace CCTV systems, developers say.

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PAM, PDM Simulator

The all-solid-state Telemetrics Model 303 provides serial pulse trains of PAM/RZ, PAM/NRZ and PDM signals, precisely simulating the output of FM, PAM and PDM receivers, mechanical



and electronic commutators, sub-carrier discriminators or tape recorders. Such versatility makes this unit valuable in calibrating and checking out telemetry ground stations, data-transmission links or data-acquisition systems.

Continuously variable commutation rate ranges from 10 to 60k pulses per second. Frame length is continuously variable from 1 to 2048 channels. A subcommutated channel can be substituted at as many as eight different locations in the pulse train, with any percentage of amplitude up to full scale.

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Silicon Transistor

A 1.6-gigacycle (maximum) silicon planar epitaxial transistor operating with at least twice the power gain and amplification of previously available devices has been developed by the Raytheon Corp., Semiconductor Div.

The 2N2808 has an a-c current gain of 5 at 200 megacycles making it adapted for use as an RF amplifier to 500 megacycles and an oscillator to 1.6 gigacycles.

Power gain is 20 db measured at 200 megacycles with a collector-to-emitter voltage of six volts and a collector current of two milliamperes.

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Velocity Deviation Unit

An instrument for precise measurement of velocity deviation, in any application where the deviation can be converted to low-level sine-wave signals, is available from the Westinghouse Scientific Equipment Dept.

Typical applications include precise measurement of gear noise, flutter and wow in tape and disc recorders; detection of cyclic variations of frequency in pulse generators and oscillators; and determination of disturbances in rotating machinery.

The instrument will measure either linear or angular velocity deviation with a sensitivity of 0.001% through the frequency range of 900 cycles to 50 kilocycles, with an overall accuracy of better than 1%. Deviation frequency is up to one kilocycle.

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names in the news

John R. Yoder: Appointed director of research on laser applications, Barnes Engineering Co., Stamford, Conn.

Delbert Davison and John E. Anderson: Elected to the board of directors of Missile Systems Corp., Los Angeles.

Theodor H. Braun and William W. Parsons: Appointed senior vice presidents of System Development Corp., Santa Monica, Calif.

Dr. Edward L. Harmon: Appointed product manager for rocket cases, Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

Dr. Daniel Q. Posin: Joined Rosae, Inc., Eau Gallie, Fla., as chief scientific consultant.

Emanuel Davis: Appointed director of quality control and reliability of General Instrument Corp.'s Rectifier Div., New York City.

Frank H. Ford: Appointed assistant to the president of Research-Cottrell, Inc., Bound Brook, N.J.

Robert C. Smith: Appointed assistant treasurer of Cubic Corp., San Diego, Calif.

Maj. Gen. Alvin C. Welling: Deputy commander for site activation for the Ballistic Systems Div., USA, named Atlantic Div. Engineer for the Army Corps of Engineers, Atlanta, Ga.

P. M. Prophett: Appointed director of advanced product planning, General Dynamics/Astronautics, San Diego.

Dr. Tarani Chandra Bhadra: Joined Electro-Optical Systems, Inc., Pasadena, Calif., as a physicist in the Quantum Physics Div.

Gordon E. Frederick: Appointed manager of field sales for General Atronics' Military Electronics Div., Philadelphia.

George Q. Herrick: Appointed product manager at Singer Metrics Div. of the Singer Manufacturing Co., Bridgeport, Conn.

Terry Taugner: Appointed manager of administrative services of Computer Control Co., Los Angeles.

Robert F. Hurt: Elected a corporate vice president of Lockheed Aircraft Corp., Burbank, Calif.

Murray H. Feigenbaum: Named assistant to the president of Polarad Electronic Instruments Div. of Polarad Electronics Corp., Long Island City, N.Y.

Hugh J. Daly: Elected vice president for corporate sales of Dorsett Electronics, Inc., Tulsa, Okla.

Claggett A. Jones: Appointed manager of the Washington D.C., office of the Defense and Space Systems Marketing Div. of the Burroughs Corp.

Morgan E. Chase: Named director for material for military systems, Lockheed Electronics Co., Plainfield, N.J.

Joseph E. Boland: Joined the Martin Co., Baltimore, Md., as a special assistant to the president.

Sy Diamond: Appointed director of marketing, Pacotronics, Inc., Glendale, N.Y.

William B. Henderson: Named Westinghouse Co.'s resident manager at the Nuclear Rocket Development Station, Nev.

Richard W. Powell: Appointed associate director of Aerojet-General Corp.'s *SNAP-8* division, Azusa, Calif.

Dr. William F. J. Hare: Named director of research at CTS of Canada, Ltd., Streetsville, Ontario.

George Sherman: Appointed industrial relations manager of the Fairchild Cable Div. of Fairchild Camera and Instrument Corp., Joplin, Mo.

Dr. Martin Rome: Appointed manager of the Photoelectric Dept. at Electro-Mechanical Research, Inc.'s Princeton, N.J., division.

Merlin E. Nelson: Appointed chairman and managing director of American Machine and Foundry Ltd., London.

Vernon L. Smith: Appointed chief engineer at Radiation, Inc., Stanford, Calif.

Col. Langdon F. Ayres (USAF ret.): Joined Aerojet-General Corp., Azusa, Calif., as assistant to the executive vice-president.

Homer D. Dargert: Appointed West Coast regional sales manager for General Time Corp., Los Angeles.

Richard A. Wilson: Appointed president of General Dynamics/Electronics, Rochester, N.Y.

E. Gary Clark: Named vice president-Defense and Space Systems Marketing Div., Burroughs Corp., Detroit, Mich. **Dr. Charles L. Register** appointed vice president-Burroughs Laboratories and **Harry B. Rottiers** appointed vice president-Contracts Administration Div.

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APRIL

American Institute of Electrical Engineers, Biennial Electric Heating Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., April 9-10.

Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by ASME, IAS, AIEE, IRE and University of California, University of California, Berkeley, Calif., April 10-11.

Electrochemical Society Spring Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., April 14-19.

International Symposium on Optical Masers, sponsored by Polytechnic Institute of Brooklyn, IRE, Optical Society of America, AIEE and U.S. Defense Research Agencies, New York City, April 16-18.

AIEE and IRE International Nonlinear Magnetics Meeting, Shoreham Hotel, Washington, D. C., April 17-19.

Institute of Environmental Sciences, Technical Meeting and Equipment Exposition, Statler-Hilton Hotel, Los Angeles, April 17-19.

Institute of Radio Engineers, Southwestern Conference and Electronics Show, Dallas Tex., April 17-19.

American Astronomical Society Meeting, University of Arizona, Tucson, Ariz., April 17-20.

AIEE Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, Ohio, April 22-23.

IAS National Meeting on Manned Space Flight, Dallas, Tex., April 22-24.

American Physical Society Meeting, Washington, D. C., April 22-25.

Hypersonic Ramjet Conference, sponsored by ASME, ARS, and U. S. Naval Ordnance Laboratory, White Oak, Md., April 23-25.

National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla., April 23-25.

AIEE Power Industry Computer Application Meeting, Westward Ho Hotel, Phoenix, Ariz., April 23-25.

AIEE Southeast District Meeting, John Marshall Hotel, Richmond, Va., April 24-26.

IRE Regional Technical Conference, San Diego, Calif., April 24-26.

Society for Industrial and Applied Mathematics Spring Meeting, Stanford Research Institute, Menlo Park, Calif., April 26-27.

AIEE Electro-Nuclear Meeting, Richland, Wash., April 29-30.

Institute Society of America, National Analysis Instrumentation Symposium and Exhibit, Rice Hotel, Houston, Tex., April 29-May 1.

American Society of Tool and Manufacturing Engineers, Annual Engineering Conference and Exposition, International Amphitheater and Conrad Hilton Hotel, Chicago, Ill., April 29-May 1.

Society of Photographic Scientists and Engineers, Annual Conference, Ambassador Hotel, Atlantic City, N. J., April 29-May 3.

MAY

American Institute of Electrical Engineers, Great Lakes District Meeting, Blackhawk Hotel, Davenport, Iowa, May 1-3.

American Rocket Society and Aerospace Medical Association, Bioastronautics Conference, Los Angeles, Calif., May 2.

Institute of Radio Engineers, National Symposium on Human Factors in Electronics, Marriott Twin Bridges Motor Hotel, Washington, D. C., May 2-3.

American Institute of Chemical Engineers National Meeting, Statler-Hilton Hotel, Buffalo, N. Y., May 5-8.

Aerospace Reliability and Maintainability Conference, sponsored by ASME, SAE and AIAA, Marriott Motor Hotel, Washington, D. C., May 6-8.

Instrument Society of America, National Aerospace Instrumentation Symposium, Jack Tar Hotel, San Francisco, Calif., May 6-9.

American Society of Mechanical Engineers, Production Engineering Conference, Netherland-Hilton Hotel, Cincinnati, Ohio, May 7-9.

Electronic Components Conference, sponsored by AIEE, EIA and IRE, International Inn, Washington, D. C., May 7-9.

Society for Experimental Stress Analysis, Spring Meeting, Benjamin Franklin Hotel, Seattle, Wash., May 8-10.

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Go or No Go

FATE OF THE *Dyna-Soar (X-20)* program remains one of the most important decisions facing this Administration. Secretary of Defense McNamara has outlined plans which could lead to Air Force acquisition of *Gemini* program management, as we noted last week. But, we would like to re-emphasize, *Blue Gemini* is not an alternative to the *X-20* project.

From a scientific standpoint, there are four flight regimes which must be fully explored as this nation develops its technical capabilities. These are subsonic, supersonic, hypersonic and orbital. Past and present research has been oriented to cover three of these.

But the fourth, hypersonic, has been bypassed. We are attempting to jump from the supersonic research provided by craft such as the *X-1* and *X-15* to the orbital research of spacecraft such as *Mercury* and *Gemini*. The *X-15* has probed into the lower regions of the hypersonic regime. But a large gap exists in our scientific knowledge between Mach 6 and Mach 25.

As this nation pushes into areas such as *Aerospace Plane*, our designers are being forced to extrapolate their data curves in the hypersonic area. We should be in a position of interpolating from, not extrapolating to, the hypersonic unknowns.

The *X-20* provides a tool for exploration of this regime.

The tragedy of the *X-20* project is the internecine warfare which has plagued it at many levels since its inception. This is actively continuing today —and should be brought to a conclusion before the project collapses because of it.

First, of course, has been the struggle between the Air Force and NASA for a primary role in manned spacecraft programs.

But even within the Air Force itself there has been continual argument over the direction of the *X-20* program. It becomes necessary at this point to distinguish between *Dyna-Soar* and *X-20*. There are many Air Force proponents of *Dyna-Soar* as a boost-glide weapon system, not as a research project. This group still is active, and some, in fact, regard designing of an orbital capability into *Dyna-Soar* as an unnecessary complication. To this group, *Dyna-Soar* is an extension of present manned bomber and reconnaissance capabilities.

Set off against those who regard *Dyna-Soar* as desirable solely because of its potential as a weapon system are those who feel its significant value lies in its research contributions. To the first group, *X-20* is desirable as an experimental prototype. To the second, it is needed as a research vehicle of the *X-15* type. The latter argue that *X-20* exploration of advanced technology in a research role will benefit many programs, just as the *X-15* has. They do not see it as the beginning of an operational system.

But the argument does not end there. Even those who are interested in the *X-20* as purely a research project are not in agreement among themselves. Design and re-design of the *X-20* has been under way for many years, since original Air Force acceptance of the concept in 1956.

The faltering and splintered support for the program has kept it at a snail's pace. Inevitably, as design engineering and research into such areas as materials continued, improvements became possible.

In one sense, the craft to be built by Boeing under the current concept admittedly is already obsolete. An advanced design now on the drawing boards offers much greater capability. The question at issue is whether to proceed with the present design or to scrap it in favor of the more advanced vehicle. The latter course, naturally, would put the first flight date further off.

There is no doubt—and many at Boeing agree—that the new *X-20* design has much to offer.

But as we see it, too much time already has been wasted and further delay can only endanger the program. An improved version can be cranked into the project further downstream. It is equally important to get started with test and checkout of the *Titan II* and *Titan III* booster systems and all the vast ground complex which will support not only *X-20* but other systems which will be modular plug-ins atop the big space boosters.

THOSE CONCERNED with the *X-20* program should come quickly to an agreement on several points:

- *X-20* is needed as a research craft to explore the hypersonic flight regime and the use of a lifting body in the orbital regime.
- The present *X-20* design can accomplish that.
- The accomplishment at a date as early as possible is vital to a number of other projects, one of which could be an experimental prototype of a *Dyna-Soar* weapon system if it then appears desirable.

Those who now are pushing *Dyna-Soar* as a weapon system are clashing head-on with Mr. McNamara. He is committed to a philosophy of exploring basic technology prior to funding costly weapon systems whose technology is unproven. These advocates will not succeed in overcoming Mr. McNamara's determination on this and are only endangering the entire *X-20* project. Those who advocate scrapping of the present *X-20* are posing the risk of dangerous delay in the program.

It is a simple question of go or no go. The decision is long overdue.

William J. Coughlin



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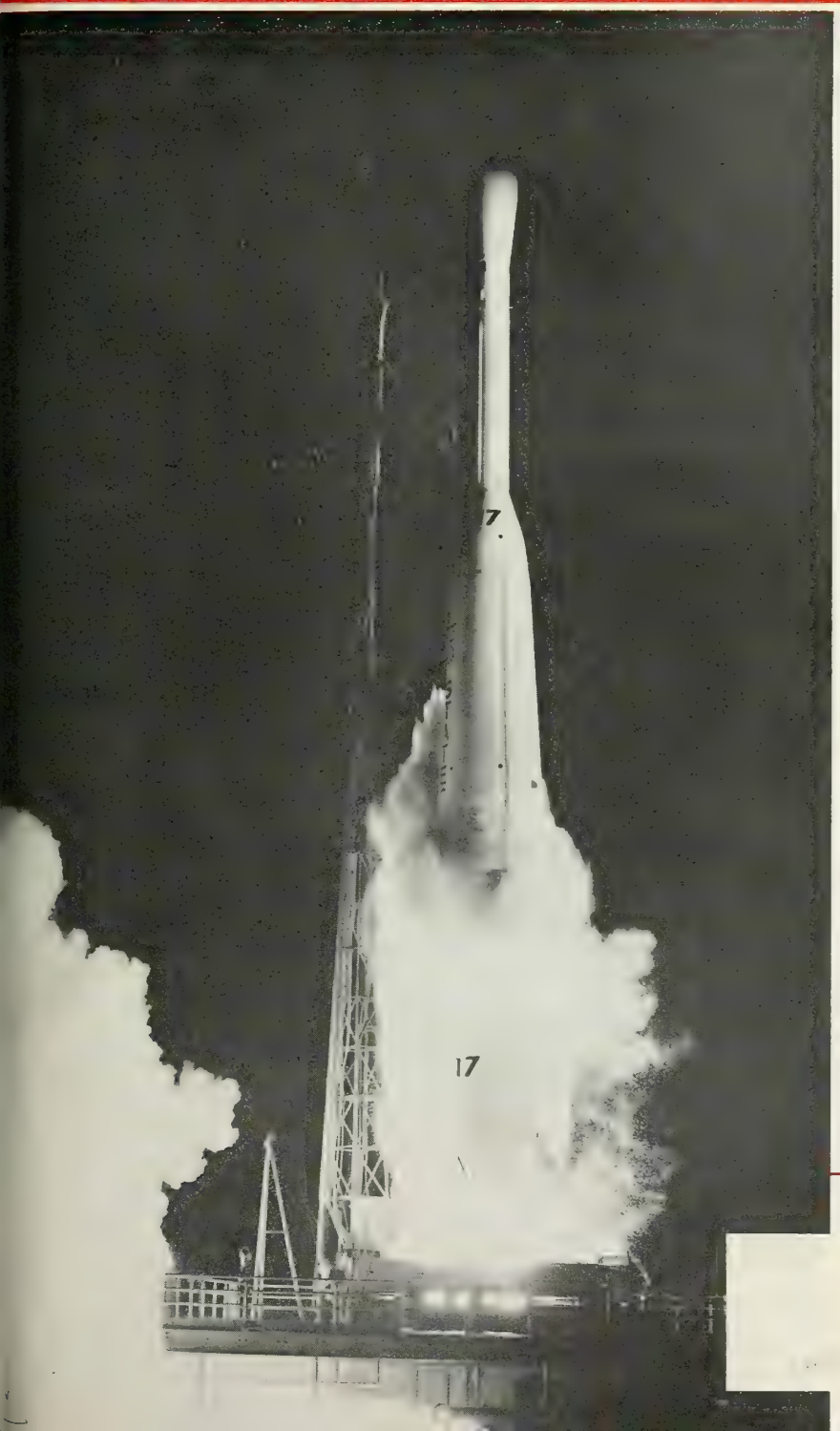
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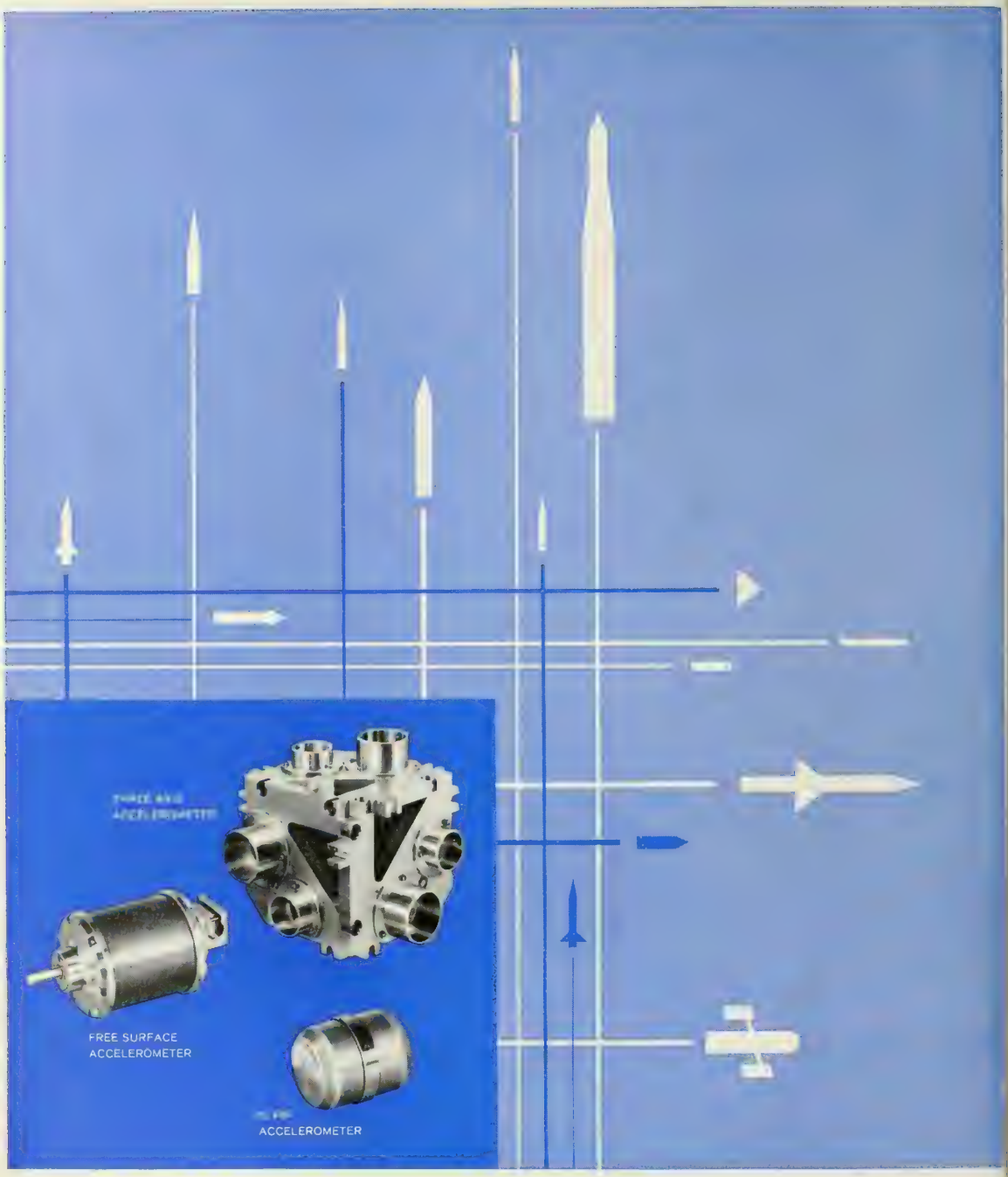
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Volume 12, Number 15 April 15, 1963

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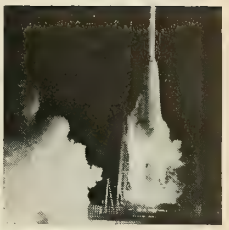
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THE COVER



Explorer XVII rises from Cape Canaveral on night of April 2. The 410-lb. satellite has been sending back a wealth of fresh data on neutral gases in the upper atmosphere following its launch on a Delta vehicle. It was Delta's 16th straight success.

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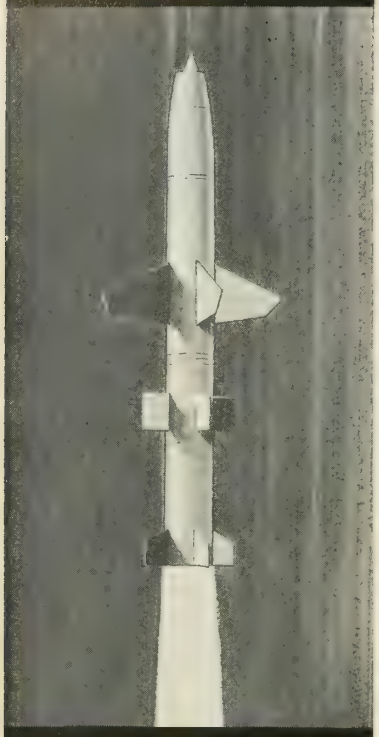
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letters

Conflict of Interest

To the Editor:

The issues raised in your editorial "Conflict of Interest" (M/R, Feb. 18) are admittedly complex, and the number of people involved require almost a complete lapse into generalities. Some of the things you say are true; some of them are implications defying facts but recognizing "feelings;" and unfortunately the whole editorial in total context is "destructive" from the point of view of military officers.

First, we would be wrong to assume that there are not "bad apples" in any barrel. There are, for the sake of argument, some bad apples in the career military officer barrel. These men, following our assumption, would sell their country for a few dollars. If we accept this, we must also accept the assumption that there are bad apples in the civil service barrel, the reserve officer barrel, the Congressional barrel—in fact, in every large group of men.

Second, we must admit that there are people stationed in the procurement areas that are less than completely honest. In fact, we could pose a spectrum for these people. At one end, we put those that can be bought hook, line and sinker with cold cash. At the other, let's put people who might be prejudiced simply because somebody was more considerate of them, or had served with them somewhere—nevertheless, these people are weak, by definition, because they are not totally objective.

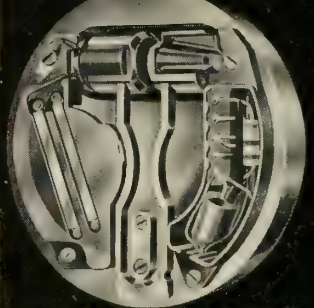
Somewhere along in this spectrum, then, we might as well rule out retired officers working in industry. If a man can be bought, why use a middleman to buy him—and take the risk that the natural ethics, integrity, and dedication of the average officer might upset your applecart?

Third, we must now ring in industry. We must admit that there are unethical and less than thoroughly honest firms and corporations, who will hire a retired officer for the sole purpose of "using" his influence. Now, let's look at salaries. Using the Congressional hearings which you used to show that 1400 retired officers above the rank of major work for the 100 largest defense firms, we find that the average salary paid these men is a few dollars less per month ($950) than received by a major with 16 years' service, and a few dollars more than that received by a Navy lieutenant on flight pay.

Many of the officers receive far more than the $950 average. Most of these men were handed the highest responsibilities the Government can give a military man on active duty . . . administered millions of dollars and thousands of men. Unless we are willing to admit that these senior officers were incompetent to shoulder those responsibilities, then we must admit that they are competent to handle equal responsibilities in industry—and should be paid for doing so.

But eliminating the top-salaried people (and if you look carefully at the Hébert list, you will find over half of the $20,000 and above men listed were "reserve type"

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generals, called in during World War II and returned to industry), let's look at industrial competition. If Company "A" thinks Col. "B" is worth $X a year, why doesn't Company "C" compete for his services? After all, we have assumed Col. "B" has decided to peddle his influence and use his old contacts. Can we assume he is too dumb to bracket the market before he takes a job?

So, from that marvelous leavening influence of all civilian life—money—it is awfully difficult to support a case *in fact* as set out in your editorial. The names are public, the salaries public, and anyone who wants to analyze individual cases is at liberty to do so.

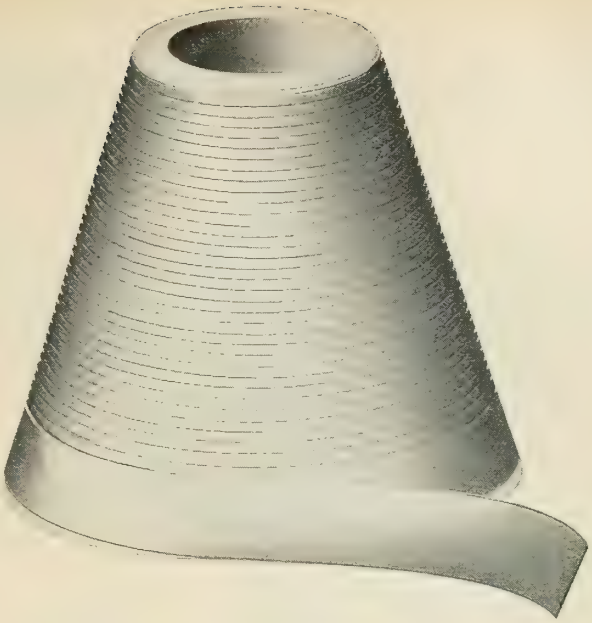
Now, you stated as a fact that people in high places believe that it is true that before retirement an officer might make decisions (wrongfully) in favor of Company "X" in hopes of a quid pro quo of a job when he retired. I agree. My only contention is that I wish that those who believe it is a fact would come forward with substantial and concrete evidence to back up their feelings. I don't think that magazine editors, with a public voice, would sit back for a minute in the face of broad and generalized attacks on the basic integrity of their press—or themselves personally. As the pot has stewed, the paucity of evidence has become more and more pronounced. Let's smoke these dishonest officers out—put up or shut up.

For, what we are doing by our innuendos and derogations is seriously affecting the entire security of the nation. First, it is devastating to the young career-minded officer to realize that all of his superiors are suspect—and that he too will be suspect. Evidence: the Navy alone is 4000 officers short in the lieutenant/lieutenant commander grades. I also have a personal file of letters from young officers of every service backing up my current suit against the Government. Second, for the about-to-retire officers, their outlook is grim. Industry is "scared" to hire them. Evidence: letters from companies frankly stating (and these are brave companies) that they do not hire retired officers, period. Other evidence: the layoffs in early 1962 when DOD 5500.7 (enrollment) was issued.

But these personnel factors are negligible when we line up the real problem. Suppose we read in the press that the Soviet Union had barred its retired military officers from working for Soviet War Industry in any connection whatsoever for three years, and for life without connection to their original service? Unless the Cold War is a myth, and the Soviets have lost all fear of us, I think we'd think they'd lost their minds.

You state that you do not believe that a truly capable military officer should be denied the opportunity to find a niche in industry. By innuendo then, you are separating the clan into two classes. With hump legislation throwing these men out by the thousands now, you are tarring some of the most dedicated and capable Americans with a pretty broad brush. Who will judge the "ept" from the "inept?"

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Captain, U.S. Navy (Ret.)
Annapolis, Md.



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The Countdown

WASHINGTON

NASA to Ask Bids on Surveyor Orbiter

As soon as NASA's Fiscal '64 budget is approved, the space agency will ask for competitive bids on the development of the *Surveyor* Orbiter spacecraft. Meanwhile, a design by Hughes Aircraft, prime contractor for the *Surveyor* Lander program, already has been received—together with unsolicited proposals from other firms.

Musical Chairs in the Pentagon E-Ring

Watch for Brockway McMillan to be named as Under Secretary of the Air Force, filling the vacancy left by Joseph Charyk. Most likely candidate for McMillan's former post of Assistant AF Secretary (Research and Development): Eugene Fubini, now deputy director of Defense Research and Engineering. Possible replacement for Fubini: Lawrence Kavanau, special assistant to DDR&E for space.

Few Long-Duration Gemini Flights Planned

NASA's current planning calls for only two or three long-duration *Gemini* flights. The eight rendezvous flights will be in orbit only for short periods. Reason: the 700 lbs. of fuel which must be carried on the spacecraft for the final docking maneuver prevent it from achieving a sufficiently high orbit for a long-duration mission. First *Gemini* flight capsule now is scheduled for delivery to NASA in September or October.

Two Soviet Moon Failures Are Reported

Lunik IV, according to official sources, was the third unmanned moon shot attempted by the Soviet Union this year. In the first two attempts, the upper stages failed to fire—leaving the spacecraft in a parking orbit around the Earth.

NASA Interest in X-20 Is Increasing

If Dept. of Defense agrees to continue *X-20* as a low-priority *X-15*-type research program, look for NASA to share in the funding. The space agency's Office of Advanced Research and Technology has submitted a report to DOD strongly endorsing the research value of the project. Top NASA officials have made it clear in testimony before Congress that they want the program continued because of the re-entry technology it will provide. NASA has no interest in *Dyna-Soar,* however, as an extensive manned spaceflight program.

NASA to Study New High-Energy Engine

A feasibility demonstration of a new high-energy engine using fluorine as the oxidizer will be undertaken by NASA during the next fiscal year. Building of a small experimental engine for use in a solar probe is under consideration. Another possible approach: modification of an existing engine.

Vibration Problem Still Plaguing Titan II

Air Force still has not licked the vertical vibration problem which has cropped up in almost all of development flights of the *Titan II.* While it has no implications for military use of the missile, the problem must be solved before the launch vehicle can be used in the *Gemini* project. NASA officials say the vibrations are sufficient to prevent the astronauts from reading the instrument panel.

Terhune Is Assigned to Project Forecast

Maj. Gen. Charles H. Terhune, commander of the Electronics Systems Division of Air Force Systems Command, has been named to head Project Forecast. More than 200 top AF and civilian experts will be in the study group, expected to report its findings in three to five months. Forecast is the full-dress projection of Air Force systems needs in the 1970's, scheduled to get under way at AFSC's Space Systems Division this month.

INDUSTRY

Big Battery Market Foreseen for Industry

As many as 35,000 batteries will be required for NASA spacecraft missions in 1967. That estimate comes from a recent study made by Armour Research Foundation for the space agency. The report also lists the major technical problems in this power area—case-to-seal leakage, separator deterioration and loss of electrode material.

Industry Comment Invited on Patent Bill

Sen. John L. McClellan (D-Ark.) has invited industry to comment on his bill to establish a uniform government patent policy under which the government would require little more than a royalty-free license from inventors working under government contracts. McClellan, head of a judiciary subcommittee on patents, trademarks and copyrights, recently introduced the bill in the Senate.

Bellcomm, GE Apollo Roles Will Expand

Further expansion of the Bellcomm and General Electric roles in the *Apollo* program can be expected, according to NASA officials. The Bellcomm organization, operating under an 18-month $8.5-million systems engineering contract, is expected to employ 250 technical and supporting staff people by year's end. Current figure: 161. Similiar growth is expected for GE, which is responsible for checkout, reliability assessment and integration.

Small Business Interested in ComSat

The Senate Small Business Committee has urged Congress to pass legislation making the Small Business Administration a partner in regulating procurement activities of the Communications Satellite Corp. Legislation could be modeled on a measure recently adopted to cover small business participation in defense buying, the committee said.

Antenna Erected for Transmission to Satellites

Philco Western Development Labs has completed design and construction of a 60-ft.-dia. dish antenna for the first communications station designed to inject information into Navy navigational satellites. The Pacific Missile Range antenna, located near Pt. Mugu, Calif., will transmit orbital positions and time data into a satellite memory unit for re-broadcast to ships. Viola Construction Co., Oxnard, Calif., built the 30-ft. tower.

INTERNATIONAL

Woomera Preparing for ELDO Rocket

The work of extending the *Blue Streak* launching tower at Woomera, Australia, to take the three-stage ELDO rocket now is nearing completion with insertion of a new section. The tower is expected to be ready for use in June.

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The Missile/Space Week

Shots of the Week

The Navy's April 8 successful firing of a *Polaris A-3* IRBM from a Cape Canaveral launching pad was dimmed by an April 10 failure of the same missile in the Navy's first attempt to launch it from a ship. In the successful April 8 shot, the *A-3* traveled 1800 miles into its target area in less than 20 minutes, marking the third success in 11 launches of the *A-3*. In the ship-launch two days later, the missile had to be destroyed seconds after liftoff, when it veered sharply off course.

Among the week's other shots:

- The Army's final *Pershing* R&D program firing on April 3 resulted in a successful 200-mile flight down the Atlantic Missile Range. The 52-shot test series, which began in Feb. 1960, resulted in 44 successes, six partially successful firings and two failures.
- The *Pershing's* post-R&D program began on April 5 in an integrated service test near Martin's Orlando, Fla., plant. The 300-mile firing followed a 40-mile tactical cross country march over secondary and hard surface roads and met all test objectives, including further evaluation of aeroballistics and the missile's inertial guidance and propulsion systems.
- A Wing II *Minuteman*, launched from a silo at Cape Canaveral on April 10, made a successful flight nearly 5000 miles downrange to its Ascension Island splash net. Air Force spokesmen said the shot met all test objectives, which were primarily focused on the missile's in-flight performance.

Nike-Zeus Funds Voted

The Pentagon has been awarded more unwanted money, à la RS-70, from the Senate Armed Services Committee in the form of production funds for *Nike-Zeus*.

The committee voted $196 million solely for *Zeus* production, the first such funds ever approved for the system.

Committee Chairman Richard Russell (D-Ga.), who had made a similar gesture himself to add RS-70 funds, promised a Senate floor fight against the *Zeus* move. The committee vote was spurred by Sen. Strom Thurmond (D-S.C.), who lined up previously unwilling Senators to put the action across.

NASA Still For X-20

NASA officials are still supporting continuation of the Air Force's *Dyna-Soar (X-20)* manned spaceflight project.

Milton B. Ames, director of space vehicles in the Office of Advanced Research and Technology, told Congress last week that, if the project is abandoned, the currently underdeveloped technology of space vehicle re-entry will be retarded.

If *Dyna-Soar* is cancelled, Ames told a House Space Subcommittee, "we will have to find some other way of adding to re-entry technology before advanced manned space projects can be successful."

He said that the project is complementary to both *Apollo* and *Gemini*. "I hope we can find some efficient, economic means to use *Dyna-Soar*. It will fill a large gap in our research program," Ames noted.

M-1 Engine Thrust Uprated

The thrust of Aerojet-General Corp.'s M-1 engine has been increased to 1.5 million lbs. and design features provide for even greater thrust and performance growth potential.

Two Aerojet officials told a meeting of the Society of Automotive Engineers in Washington, D. C., that the uprated thrust was the major design change made in the engine since the firm was selected to build it in April 1962.

Dr. J. C. Moise and D. E. Price also told the meeting that another major change in specifications calls for reduction of pump suction pressure requirements.

Explorer Does Itself Proud

The *Explorer XVII* satellite during its first few days of operation has sent back to Earth data that more than triples all previous direct measurements of the neutral gases in the upper atmosphere.

Both quantity and quality of the data are excellent, scientists at NASA's Goddard Space Flight Center at Greenbelt, Md., reported.

NASA said the satellite, traveling in an egg-shaped orbit ranging from 157 to 578 miles high, has been commanded "on" more than 75 times. Each time the satellite responded with approximately four minutes of data on the density, pressure, com-

position and temperature of the tenuous gases that make up the upper atmosphere. Previous rocket and satellite measurements in this region of space were on the order of minutes, rather than hours, with few direct measurements to substantiate some physical theories.

The 410-lb., beachball-shaped satellite was launched April 2 from Cape Canaveral by a *Delta* rocket. It was the sixteenth straight success for *Delta*, and the satellite was taken aloft only 2.2 sec. beyond the planned liftoff time. The stainless steel spacecraft orbits the Earth once each 96.4 min.

Rubel Discusses Advent

The first medium-altitude communication satellite for the re-oriented *Advent* program may be launched by the Defense Department in January, 1965, according to John H. Rubel, Deputy Director of Defense Research and Engineering.

And, he predicts, a fully deployed system could be operational before the beginning of 1966.

However, Rubel told a House Space Subcommittee last week, there are two prerequisites for this schedule to be met: 1) a DOD decision to go ahead with its plans for such a system; and 2) success of a substantial number of the multiple launches that are scheduled for Calendar 1965.

But Rubel noted that discussion even of development of such a system continues to be premature, as a go-ahead decision probably will not be made before the end of this year. And he estimated that a series of unexpected failures in the program might delay the overall schedule by as much as a year.

Rubel gave the committee an outline of the program as it now stands: next month, a program-definition-phase contract will be awarded for studies to be completed by August; September will see a follow-on contract for phase two of the study, to be completed by November; and, at that time, DOD will make either a "go" or "no-go" decision before issuing detailed hardware and research contracts.

Voyager Studies Awarded

Avco Corp. and General Electric Co. have been selected by NASA for two design study contracts for the *Voyager* spacecraft program.

The two $100,000 awards will cover six months. *Voyager* would be a 6000-lb. unmanned spacecraft for flights to Venus and Mars after 1967.

In another procurement action, the space agency announced that seven firms have submitted bids for study contracts on the proposed biosatellite program.

The firms are Lockheed Missiles & Space Co.; GE's Missiles and Space Vehicles Div.; McDonnell Aircraft Corp.; Bendix Systems Div.; Ford Aeronutronic Div.; General Dynamics; and Northrop Space Laboratories.

Ames Research Center spokesmen said two to four of the bidders will be selected for $80,000 contracts by about April 15.

Space Station Patented

Lockheed Missiles and Space Co. believes it is the first firm to receive a U.S. patent on a space station design. Lockheed and the Patent Office revealed the award last week.

The patent covers a design for a 216-ft., nuclear-powered, prefabricated space station, to be assembled in space from cylindrical and spherical subsections.

Orbital lifetime of the station is estimated at about four years, but could be extended by restoring it from time to time to its proper orbit, Lockheed says.

USAF Minuteman ICBM uses GLC Graphite in First Stage Rocket

Rocket nozzles and convergent-divergent cones made of Great Lakes Carbon Corporation's **HLM-85** grade graphite are standard in the first stage solid propellant motor developed by Thiokol Chemical for the Minuteman missile.

GLC's **HLM-85** graphite is distinguished by high density, great erosion resistance and economy of performance.



HLM-85 graphite is in full production. Ample supplies are available in a wide choice of sizes and shapes.

Exotic grades of GLC graphite are also being developed in our research laboratories to meet advanced applications in aerospace technology. Your inquiry is cordially invited and will receive immediate attention.

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ABRES Firings Going to PMR

New re-entry vehicles to run against PRESS and Nike systems at Kwajalein from Vandenberg

by Frank G. McGuire

THE AIR FORCE plans to shift firings of its advanced ballistic re-entry systems (ABRES) from the Atlantic Missile Range to the Pacific Missile Range to take advantage of ICBM-defense facilities in evaluating the ABRES effectiveness.

This also will enable Advanced Research Projects Agency and the Army to obtain missile-defense data from the most advanced targets available. The firings will begin within the next few months and will take place from Vandenberg AFB, Calif., landing near Kwajalein Island.

Downrange facilities to be used in the program include ARPA's Pacific Range Electromagnetic Signature Studies equipment (PRESS) and the *Nike-Zeus* and *Nike-X* facilities. It is the PRESS equipment which primarily interests the Air Force in its plans to check the effectiveness of the new-re-entry vehicles.

Informed sources say "quite a few shots are planned," and at least one Advanced Range Instrumentation Ship (ARIS) will be assigned to the Pacific project. The launchings are expected to take place over a number of years as refinements and modifications are introduced into all systems concerned.

The ABRES vehicles will be launched aboard *Atlas* and possibly other boosters, and continued use will be made of routine training shots by Strategic Air Command crews to help gather anti-ICBM data by Army and ARPA equipment. Another major item in ARPA's ballistic missile defense picture is the Tradex radar on Roi Namur, an island in the Kwajalein group. The Tradex facilities were completed and turned over to ARPA in November.

● **PRESS expensive**—From a cost standpoint, PRESS is the major portion of ARPA's Defender program, the overall effort to develop missile defense as a science. Defender carries out R&D on ballistic missile defense, rather than trying to develop a weapon system, which is the Army's responsibility.

About 120 scientists and engineers are based on Roi Namur in support of PRESS activities. The island is roughly 4500 ft. wide by 10,000 ft. long, with a pinched waist. Less than 50 miles away on Kwajalein itself, the Army's *Nike-Zeus* and *Nike-X* program is under way.

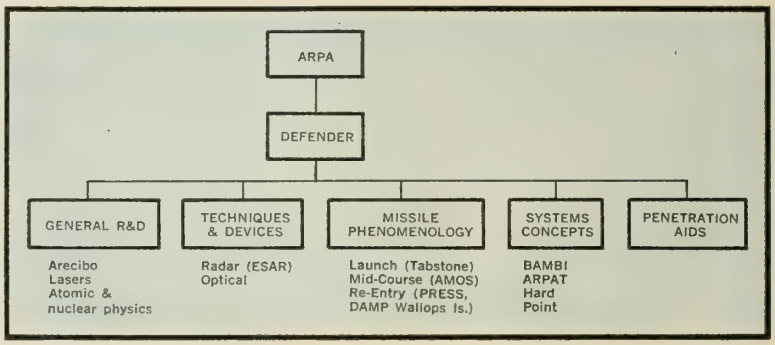


TABLE SHOWS research programs being conducted under Project Defender.

The complementary nature of Project Defender and *Nike-Zeus*, wherein ARPA uses science and technology to provide a basis for evaluating the performance and potential of the weapon systems being developed by Army, encompasses such widespread activities as the Arecibo 1000-ft. dish in Puerto Rico, Bendix's ESAR (electronically scanned array radar) installation, TABSTONE (target and background signal-to-noise experiments) at the Atlantic Missile Range, and systems concepts still on paper.

● **Mid-course detection**—A recent facility is the AMOS (ARPA Mid-course Observatory Site) at Maui, Hawaii. This location has two 48-in. optical telescopes designed to observe ballistic missiles during the mid-course phase of their flight. Only a dozen or so telescopes in the Free World exceed these units in size. Astronomers from the Sacramento Peak Observatory in Arizona will participate in the program.

Initiation of the AMOS effort is indication that mid-course detection and tracking of ballistic missiles is getting more attention than previously. But there is still no great backing for the hope that mid-course action will solve the ballistic missile defense problem.

Moving even further backward along the missile trajectory, TABSTONE is designed to provide data on launch phenomena of ICBM's, and is being conducted at the Atlantic Missile Range. Project Defender personnel are using both aircraft and rocket probes to acquire data.

The Arecibo dish is expected to produce information on perturbations of the atmosphere caused by high-speed passage of missiles from Earth's surface to space. Any large body passing rapidly through the atmosphere creates a disturbance, and ARPA hopes to develop this phenomenon to its own advantage.

Lasers are also coming in for study as a possible future weapon against re-entry vehicles.

Past statements about lasers included the possibility that they would act as a "death ray" and melt the target vehicle. ARPA spokesmen called this a highly unlikely application from a practical standpoint, but noted that seemingly less possible things have come about.

● **Other efforts**—Other research being carried on under Project Defender includes basic atomic and molecular physics research to investigate re-entry phenomena, development of optical techniques, firing of high-speed re-entry sub-scale vehicles from Wallops Island, Bambi (ballistic missile boost intercept) studies, ARPAT (ARPA Techniques) and hard-point defense. ■

For first 100-missile force . . .

Britain To Spend Billion on Polaris

One-third of cost will go for U.S.-made hardware; Royal Navy training to begin shortly; sub center sections will be U.S. design

BRITAIN will spend about $1 billion on its initial force of *Polaris* submarines, with one-third of this figure devoted to U.S.-built equipment.

Future costs will be determined by the depth to which Britain plunges into the *Polaris* concept

An agreement with the United Kingdom, providing for U.S. arming of at least four nuclear submarines with *Polaris* missiles, was signed last week.

Effect of the pact will not be felt until 1968, when the first British nuclear submarine goes on station with 16 *Polaris* missiles.

An estimated initial total of 100 missiles, minus warheads, will be bought by the U.K. with guidance, fire control, ship's navigation, and all accessory equipment.

Although official sources denied it, there is very strong evidence that secret codicils are attached to the agreement.

British participation in the program will begin "very soon." Royal Navy personnel will fire missiles from Cape Canaveral, and possibly later from their own sites.

Present cost of an *A-2* model *Polaris* is about $1 million per copy, and the U.K. cost will be about the same. U.S. Navy estimates put the approximate cost of a British *Polaris* nuclear submarine at $50 million, without missile system equipment. A U.S. *Polaris* submarine, complete with all equipment, costs about $120 million, and somewhat less than half that is for the ship itself, minus missile system. The British are expected to be able to build their submarines somewhat less expensively than the U.S.

Royal Navy sources said the fore and aft sections of the submarines will be of British design, and the central, or missile, section will be virtually a carbon copy of U.S. submarines, so that interface problems with equipment will be minimized.

● **Limitations**—The agreement, signed April 6, provides for U.S. assistance in designing the submarines, but does not permit the sale of nuclear propulsion units to Britain, nor the transfer of information about them. A similar situation exists regarding the nuclear warhead, but U.S. officials said the 1958 agreement with the U.K. allows the U.S. to transmit more information regarding warhead design than was previously permitted by the law.

The warhead will be of entirely British design, and is expected to be the equal of the U.S. version in light weight and performance.

The British now have one nuclear submarine in commission, the HMS/M Dreadnought, and have achieved criticality with several other reactors being developed for marine propulsion.

Head of the British *Polaris* program is Rear Adm. H. S. Mackenzie; the Ministry of Aviation, which has procurement authority, has named Rear Adm. F. Dossor its project officer.

The agreement, following up the Kennedy-Macmillan Nassau Pact, was signed just three days before Defense Secretary Robert S. McNamara left Washington for London to confer with British Defense Minister Peter Thorneycroft on matters "of mutual interest."

The purchase agreement holds a method of guaranteeing that U.S. tax dollars are not used to supply the *Polaris* missiles to the U.K.—all money is put into a trust fund in advance and withdrawn as equipment is delivered. U.S. officials stress that Britain is paying "her fair share" of the cost, and will deal only with the U.S. government (for which the Navy Department is the executive agent in this case) instead of individual contractors. This arrangement will assure that Britain will not have to negotiate prices separately from those prices available to the U.S. government.

● **No "escape"**—Several interesting portions of the agreement were noted: there is no "escape clause" through which either party can withdraw (though spokesmen pointed out that "what God hath wrought, he can unwrought"); there is no compulsion for the U.K. actually to order any missiles—therefore, the agreement is void if Britain simply fails to order anything. On the other hand, there is no limit to the number of missiles and equipment the U.K. can buy.

Spokesmen said there is no provision whatsoever for U.S. control of the missiles, through electronic locks on the guidance system or by other means.

● **Summary**—In essence, the significant portions of the agreement are:

(1) Each nation will name a project officer to be responsible for carrying out the provisions of the agreement. In addition, a joint steering task group will be set up to advise the project officers.

(2) Hardware includes missiles (less warheads), guidance systems, launching & handling systems, fire-control systems, navigation systems, test & checkout equipment, special power supplies, power-distribution systems and support equipment for shipboard and shore use. Training equipment, construction spares, spare parts and technical documentation are also covered.

(3) In individual cases, manufacture of hardware items by British contractors is allowed for in order to repair, modify or maintain equipment. U.S. Navy spokesmen said, however, that this deliberately does not include replacement, which will have to be done through purchase from the U.S.

(4) Use of U.S. missile ranges, support facilities and other services is guaranteed, as well as assistance in program management techniques and engineering and shipyard services. RDT&E services and training for U.K. personnel are also included.

(5) Future modifications of the system will be made available to the British, ensuring that they have the advantages of continuing R&D. If the U.S. Navy is using the *A-2* model when delivery is due, the Royal Navy will also get the *A-2*, until the U.S. begins *A-3* operations.

(6) Cost of missiles will be the same as that to the U.S. from contractors, plus appropriate allowances for work done in government facilities and further allowances for overhead and use of capital facilities. A 5% surcharge will also be paid to help cover all R&D costs after Jan. 1, 1963, and the U.K. will bear the entire cost of R&D conducted specifically for its portion of the system, as well as all costs for services specifically required by the U.K.

(7) A number of provisions make certain that blueprints and other technical data are freely available to the U.K., that no liabilities are incurred, that proprietary rights are granted, and that no transfer of any kind of hardware or information will take place to persons outside the U.K. personnel directly concerned with the operation of the agreement. ■

Titan III Seen Key to U.S. Security

'Apples and oranges' comparison with Saturn I scored; supporters say ITL concept is vital to military needs

HIGH AIR FORCE officials believe the ability of the United States to meet any future Russian military space threats may well depend on conclusions reached in a current Defense Department study of the *Titan III* program.

If these DOD studies—expected to be completed by June at the latest—indicate that costs are being held to tolerable limits, the system will go into final development phase. If not, Secretary of Defense Robert S. McNamara may recommend cancellation or cutback of the program.

Titan III defenders—fearing that cost-cutters may put more weight on financial considerations than on purely technical factors, and feeling that *Titan III* is well in line on a dollar basis—declare that the system is being compared erroneously with the *Saturn I* and *IB* launch vehicles.

"Any comparison of the two is comparing apples with oranges," a spokesman told MISSILES AND ROCKETS. "People seem to forget that *Titan III* was originally recommended by the Large Launch Vehicle Planning Group, consisting of the best booster people from both DOD and NASA. The group considered every booster available or approved for development at that time, and concluded that none of them could meet all space launch requirements in the 1965-75 time period. The result was recommendation of *Titan III* and *Saturn V*."

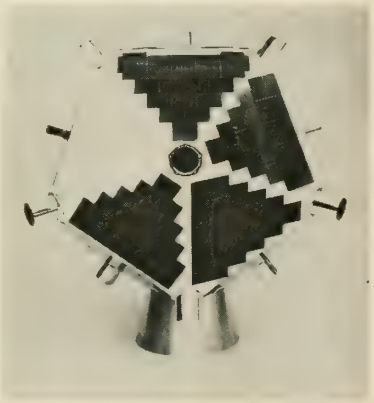
● **Talking points**—*Saturn* vehicles *I* and *IB* can perform only one mission as now configured—low-altitude elliptical orbit by direct injection—whereas *Titan III* is capable of placing payloads of between 5000 and 25,000 lbs. into low-altitude circular orbit; into a similar orbit with Hohmann transfer to another orbit; into synchronous orbit; or into deep-space trajectory to escape.

Some *Titan III* proponents estimate that an attempt to upgrade *Saturn I* and *IB* to match *Titan III* capability (by increasing thrust and adding a third stage) would result in "almost day-to-day slippage of the *Apollo* program." They believe that breaking out a separate *Saturn* vehicle upgrading effort so as not to affect the *Apollo* schedule would be costly, in view of development already devoted to *Titan III*. They also doubt that such vehicles would be ready as quickly as *Titan III* to fill the 1965-75 gap.

"And we still wouldn't have the military capability required," one source claims, "unless the integrated transfer-launch (ITL) concept were incorporated."

The Air Force stresses that only the ITL feature—providing quick launch and turn-around, plus rapid reaction to mission changes—can meet military space requirements. The slower-moving space agency, with its sights set mainly on placing a manned capsule on the Moon, could not justify the ITL feature for purely scientific exploration of space. ITL will permit 40 to 60 launches a year from just two pads.

While declining to enter into any *Titan III* vs. *Saturn* controversy, Col. Joseph S. Bleymaier, *Titan III* system program director, told MISSILES AND ROCKETS that the system will meet both military and non-military requirements in the next decade "which cannot be met by any other space launch system now under development."



Vela Hotel in Production

FIRST production model of flight spacecraft for Air Force's 823 program (Vela Hotel) will be completed soon at Space Technology Laboratories, Redondo Beach, Calif. Twenty-sided craft will detect nuclear explosions in space (M/R, Oct. 23, 1961, p. 12).

The key point involved in the *Titan III* concept—and one the military fears is not appreciated—is that, while the system provides powerful new boosters, "the boosters alone add little to this nation's capability in space, particularly in support of military requirements," Col. Bleymaier added.

Another source declared that an uprated *Saturn IB* approaching the two-million-lb. *Titan III* thrust "would leave us stuck with a big booster. We would have no orbital transfer capability—as for transferring a manned vehicle to polar orbit following launch from Cape Canaveral—as is provided by the *Titan III* transtage."

● **Dyna-Soar strain**—*Titan III* defenders are endeavoring to correct a misconception that the system's main objective is boosting *X-20 (Dyna-Soar)*. "The fact that *Titan III* was not designed solely for *X-20* is shown by the severe constraints *Dyna-Soar* places on the booster," a spokesman said.

In order to accomplish the *X-20* mission and to ensure recovery of the spacecraft in the event of an abort during launch and injection, it is necessary to set an abort ceiling—an altitude beyond which the *X-20*, if aborted, could not land in the designated recovery areas. If *X-20* is to achieve injection velocity and still remain below the abort ceiling during the booster portion of the flight, it is necessary for *X-20* to follow a difficult "roller-coaster" trajectory—one in which the booster-spacecraft combination climbs to the abort ceiling, then levels off and actually dips Earthward for a short period before climbing.

During this period, *Dyna-Soar* achieves injection velocity, its boosters are jettisoned, and *X-20* coasts to injection altitude, where the transtage engine accomplishes the actual injection. This trajectory places the most severe guidance requirements on *Titan III*.

An Air Force officer, referring to civilian space program rendezvous requirements, said that "without *Titan III* we cannot meet military needs for space rendezvous and inspection. There is little advantage in coming close enough to a foreign vehicle to be able to inspect it, unless we are also prepared to capture or otherwise negate it." ■

Goddard Management May Expand

Officials try to work out formula for Center and JPL roles in Mariner, Voyager programs

by Hal Taylor

TOP SPACE AGENCY officials now lean heavily toward giving the Goddard Space Flight Center new responsibility in its unmanned planetary exploration program.

The big question still undecided is how big a role the center will play in *Mariner, Voyager* and future projects.

An intra-agency report on the situation will be presented in the near future to Dr. Homer Newell, Director of the Office of Space Sciences. A final decision is expected in one to two months.

The immediate issue is Goddard's desire to manage and develop the spacecraft for the 1966-67 *Mariner* flights which will land small capsules on Mars and Venus.

The long-term problem is how the space agency can best make use of Goddard's technical capability and Earth-satellite experience in unmanned exploration of the planets.

The *Mariner* project is now managed for NASA by the Jet Propulsion Laboratory. The laboratory is already well along in the development of the lightweight *Mariner* capsule for 1964 missions to Mars.

Development of the heavier, 1000-1300-lb. spacecraft which will actually land small capsules on Mars and Venus has not yet begun. Currently, this is scheduled for the summer of 1963.

In the meantime, space agency officials are trying to resolve the roles of JPL and Goddard, not only in the 1966-67 missions but also in the 6000-lb. *Voyager* program later in this decade.

● **Formula sought**—As far as the *Mariner* lander program is concerned, it appears likely that a compromise solution will be recommended to Newell, an official said.

This could involve permitting JPL to continue to manage the program while Goddard developed the landing capsule.

Another possibility is that Goddard could be permitted to manage the development of spacecraft for later flights in the series.

The spokesman made it clear, however, that Goddard will be worked into the program in some way.

He said that Goddard has a great deal of experience in satellite exploration and JPL has a great deal of technical competence in planetary work. "We are now trying to find the best possible formula for making use of both," he continued.

He added that as part of the compromise a decision as to the management of *Voyager* could be put off for some time because development funds will not be available before Fiscal 1965.

● **Mariner plans**—One proposal being considered by NASA for the *Mariner* lander capsule calls for the familiar hemisphere-cone shape with a total weight of about 125 lbs.

When the shielded capsule has entered the Martian atmosphere, a parachute is deployed, the capsule shielding is jettisoned, and intermittent measurements of atmospheric pressure, temperature, composition, and light scattering are made and transmitted from the capsule directly to the Earth until the capsule touches the Martian surface. These readings are also stored in a memory for subsequent re-transmission to Earth.

After landing, measurement of these same quantities and of a biochemical growth experiment would be made and transmitted directly to the Earth at regular intervals until sunset on Mars. Sufficient battery energy will remain to maintain the capsule temperature at a satisfactory value throughout the Martian night and to permit several transmissions on the following day.

The measurements that are to be made will determine: the atmospheric temperature, pressure, and density-altitude profiles during entry into the Martian atmosphere; altitude profiles of the attenuation and of the scattering of sunlight in the blue and ultraviolet and in the near-infrared regions by haze, dust, and clouds; and mean molecular mass-altitude profile of atmosphere. ■

Air Force Lists 10 Gemini Experiments

THE AIR FORCE has given the House Space Committee a list of 10 unclassified experiments it would like to conduct as part of NASA's *Gemini* program.

The list makes it clear that if some Air Force objectives—such as inspection and rendezvous with unfriendly satellites—are to be accomplished, it will have to be done during *Gemini* missions beyond the space agency's current 12-flight program.

The list was supplied to the committee on April 4 by Dr. Brockway McMillan, assistant secretary of the Air Force.

The listed experiments included:

- Visual definition of objects in space.
- Cooperative target inspection.
- Angle-track-only rendezvous guidance.
- Hybrid IR/laser guidance equipment.
- Passive infrared star and satellite tracking.
- Visual definition of terrestrial features.
- Observation of missile launches.
- Extravehicular operations.
- Autonomous navigation.
- Radiation levels within the space capsule.

Meanwhile, a top space agency official told the Committee's manned space flight subcommittee that the space agency at this point does not expect more flights to be added to the *Gemini* program, because of the DOD-NASA agreements.

"We don't expect more flights, but we expect to incorporate in our present flights scientific experiments that are of joint use both to the DOD and ourselves," George M. Low, deputy director of the Office of Manned Space Flight said.

"The intention is that the Air Force will act as an observer by direct participation in every phase of the program. It will have people with our Manned Spacecraft Center in Houston working alongside our own engineers in order to get maximum benefit to the Air Force," he told the subcommittee.

Long Future Seen for SLV 3B Booster

Atlas-based vehicle, still to be delivered, will get crucial tests late this year; a report on plans for modification

by Richard van Osten

SAN DIEGO, CALIF.—Already slated for almost a dozen Air Force and NASA programs, the *Atlas*-based *Standardized Space Launch Vehicle 3B (SLV 3B)* may well be used in other projects that would extend its productive period into the 1970's.

This is the present thinking of General Dynamics/Astronautics, which holds a $78-million contract from the Air Force Space Systems Division for 35 of the space boosters. With an eye to follow-on orders, GD/Astronautics is studying "new" programs for the vehicle even though the first *3B* is not slated for delivery until this coming November.

Approximately $1 billion in programmed space booster vehicles over the next 10 years has been "identified in customer planning areas," according to Charles S. Ames, GD/Astronautics VP and space launch vehicle program director. Obviously not all would apply to the *3B* system because of mission requirements or payload limits. But Ames points out that an uprated *3B* vehicle is a possibility.

An SSD spokesman says Air Force portions of the present *3B* program won't be affected by any decision on the proposed *Titan II/Centaur* booster combination (M/R, Mar. 18, p. 12). He notes that "each booster system has its own job to do." But SSD is less definite about future military *3B* procurement—commenting only that the current award is "the last we let, but not necessarily the last *Atlas* contract."

It is also uncertain just how many *3B* boosters NASA will buy, whether in conjunction with the Air Force or independently. Ten *3B* vehicles in the present contract are slated for portions of NASA programs already approved and funded. But, because of the time spread of some programs, NASA is likely to need more vehicles than those presently being procured. NASA's fiscal proposals for 1964 reflect a need for a fair number of *Atlas*-type boosters. Firm procurement, however, is dependent upon how much of NASA's asked-for funding is approved and how solid certain of its programs remain.

The Air Force finds itself in a similar position—although the 25 *3B* boosters it will receive between November, 1963, and December, 1964, should handle the majority of its immediate programs. A few *Atlas* space boosters are still being supplied to the Air Force under terms of an earlier contract not yet completed.

● **Assignment**—How many *3B's* will be procured by anyone depends greatly upon the booster's success in initial launches late this year. Program assignment for the 35 units is "subject to realignment," but the tentative breakdown is as follows:

—*AMR Complex 12*—Three *SLV 3B/Agena D* combinations. One is slated for NASA's *OAO (Orbiting Astronomical Observatory)* to place the 3300-lb. satellite into a 500-mi.-high orbit. Another is assigned to NASA's *Ranger* soft lunar landing program. The third is for NASA's *EGO (Eccentric Orbiting Geophysical Observatory).*

—*AMR Complex 14*—Five *SLV 3B* vehicles to launch the rendezvous target vehicle for *Gemini.*

—*PMR/Point Arguello*—Two *SLV 3B/Agena D* combinations for NASA's *Rebound* multiple launch of three passive-type, *Echo II* communication satellites into a 19,500-mi.-high orbit.

—*AMR and PMR*—Twenty-five *SLV 3B* units, nearly all in combination with *Agena D,* for various Air Force programs. The AMR launches will include *Vela-Hotel* experiments. PMR launches will primarily involve *Samos* and *Midas* programs. One *SLV 3B Agena D* combination will be diverted to the AF/AEC SNAPshot orbital reactor test program, although the reactor was originally scheduled for launch with an *Atlas/Agena B* vehicle this year—prior to delivery of the first *3B.* Launch is now expected in FY '65.

● **Characteristics**—The third in GD/Astronautics' series of modified *Atlas D* boosters, the *3B* is specifically designed for *Agena D.* Basic *SLV 3* is the "D" model adapted for Project *Mercury's* MA series. The *SLV 3A* is a "D" with the straight-sided tank configuration for *Centaur.* There also is a "stub tank" version of the *3B* to meet *OAO* payload design requirements.

Other than for *OAO 3B,* physical characteristics are about the same as those of all "D" model space boosters. Primary difference, not readily visible, is the standardized approach—not a "tailored" or one-of-a-kind configuration. Project *Mercury* "D's," for example, had to be selected many months in advance of launch dates and modified for each specific mission. But the *3B* is a basic *Atlas* that uses only such systems as are common to all requirements. The systems and subsystems used have been selected from what GD/Astronautics believes the best of those developed in all *Atlas* series or configurations—both as a weapon system and space booster.

One major change from previous "D" space launch vehicles is the *3B's* up-rated Rocketdyne MA-5 engine, which develops 165,000 lbs. of thrust at sea level compared to the 150,000 lbs. of thrust in current "D" boosters. Sustainer engine thrust remains at 60,000 lbs. Total *3B* thrust is 390,000 lbs., up 30,000 lbs. from the "D" space launch vehicle, and about equal to total thrust of the "E" and "F" ICBM models. Another change in the MA-5 engine is the use of propellant injector baffles for smoother combustion which, in turn, tends to increase booster reliability.

Ignition reliability is expected to be increased by a switch from pyrotechnic systems of earlier boosters to a hypergolic system. A cartridge of triethylaluminum is installed in each propellent line and forced into the thrust chamber by propellant pump pressure.

Vernier engines for the *3B* have been derated to 500 lbs. thrust from the earlier 1000-lb. thrust.

The much-modified *Atlas* pneumatic system will be standardized to satisfy all known *3B* programs.

Upper-stage configuration changes required by some programs, plus the increased forward mass, have resulted in greater bending loads and greater aerodynamic loads both on the ground during high-wind conditions and in flight. Part of this requirement has been met by strengthened frame and support components in the thrust section. Some areas of propellant tank skin have been increased in thickness, similar to the project *Mercury* boosters, and standardized at the heaviest gauge required for any *3B* mission. The propellant tank mounting ring also has been reinforced.

Liquid-oxygen tank pressures will be standardized at 31 psi. Fuel tank pressure will be increased from 60 psi nominal to 67 psi.

● **Pod changes**—Retrorockets in the equipment pods, used on ICBM models, will be removed to save weight. The *3B*, like other *Atlas* space boosters, will carry retrorockets in its adapter section.

Interior of the equipment pod (long or B1 pod) will be modified for transverse rather than longitudinal mounting of equipment, with platform-type mounts installed as necessary. The electrical harness will be grouped to one pod side and tubing to the other for improved accessibility.

Electrical harnesses in both pods, thrust section, and wire tunnels will be changed to eliminate permanent splices by using "poke-home" connectors and a distribution box. Harnesses will be standard for the basic *3B*, and will be of the present open-wire type with all wiring terminating on a connector. Circuits with a single function run directly between the two associated units. Circuits with one or more possible uses are routed to a distribution box.

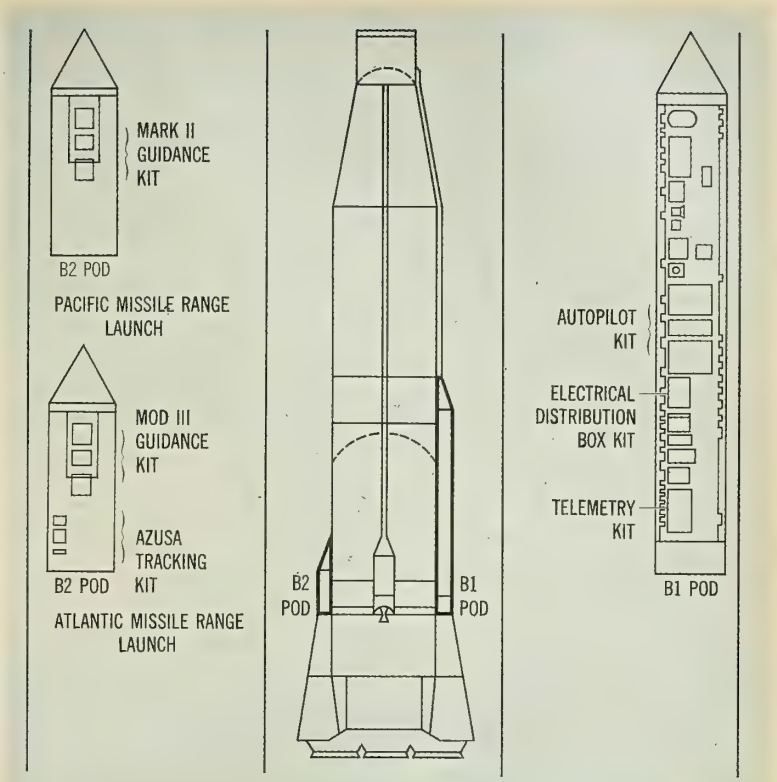
This makes it possible to effect changes at the box, eliminates a harness change, and standardizes the harnesses on all *3B's*. Structural improvements have eliminated temperature-protection wrapping of harnesses in vernier engine and wiring tunnel areas.

Proposed incorporation of a rapid, pressurized liquid-oxygen loading system for the standardized *3B* program requires extensive launch control system modifications. The system is in use at PMR and is being incorporated at AMR's Complex 13. AMR Complex 12 is the only site needing this rework under the *3B* program. Launch site modifications to standardize AMR and PMR *Atlas* facilities and aerospace ground-support equipment (AGE) for compatibility with all basic *Atlas* vehicles are included in the $78-million GD/Astronautics contract.

● **Pad alterations**—Proposed revisions of the topping control system to permit last-minute topping at flight pressure will require modifications at all *3B* pads. This capability, however, now exists at AMR Complex 13 and PMR. But the probe system is not set up for final topping at this pressure. Net effect on launch vehicle configuration is a lack of uniformity in propellant-level indication probe installations.

● **Key kits**—Mission flexibility for the *3B* has been designed around a series of system kits:

—*Telemetry*—This has been designed as a single package containing all standard instrumentation measurement provisions. Items peculiar to each program will be added to the basic unit. The kit will be slightly different for each 3B program, but it will be a requirement of both AMR and PMR.



ATLAS SLV 3B (center) with equipment pods. At left are interchangeable instrumentation kits for launch site compatibility; at right are specific mission kits.

—*Electrical Distribution Box*—Consists of a canister containing provisions for electrical connection differences between programs. It will be modified internally for each mission but will be the same externally. This is also an AMR and PMR requirement.

—*Autopilot*—Comprised of the programmer package, displacement gyro package, and the servo package, using the same canisters used on present *Atlas* boosters. Minor internal differences will be required for each program. Other autopilot equipment which does not change with each mission will be part of the basic *3B* vehicle. Required at both AMR and PMR.

—*Mod III-G Guidance*—General Electric Mod III-G guidance unit containing essentially the same parts furnished with present *Atlas* vehicles—a GFAE pulse beacon, rate beacon, decoder, antenna, GD/Astronautics-furnished interconnecting cabling and wave guide. Cabling and wave guide may differ from existing parts because of equipment repositioning and elimination of wiring splices, but all kits will be alike. This unit has been put into kit form, since it is used only on *3B's* launched from AMR.

—*Mark II Guidance*—Like the Mod III-G unit above, this GE system is comprised of the same components furnished on present *Atlas* vehicles. Used only at AMR.

—*Azusa Guidance*—Same as furnished on present *Atlas* vehicles: a GD/Astronautics Azusa "C" transponder coaxial switch, two antennas, interconnecting cabling and wave guide. The antennas may vary with each program. Used only at AMR.

GD/Astronautics thinks the kit approach a most practical answer to standardization of space launch vehicles. The possible combination of kits offers excellent flexibility. When *3B* delivery begins, each basic vehicle and each kit will be a separate deliverable item. Before shipment to a launch site, all kits required for a particular mission will be installed and the assembled vehicle will receive a final composite checkout.

Allocation of a vehicle to a specific program or mission can be reduced from about eight months to approximately 45 days before launch because all basic *3B's* will be compatible for all missions.

No manned uses of the *3B* are planned at present, assistant program director J. S. Berggren told M/R, adding that "we're shooting for the same degree of reliability." ■



The National Aeronautics and Space Administration has assigned to General Electric a major role in designing and developing integrated, automatic checkout and test equipment for the APOLLO program, in addition to supporting NASA in overall reliability of the entire system. High level specialists and systems people are being drawn from many components of the company to contribute to the design and development of computerized semi-automatic and automatic checkout systems. Additional highly qualified engineers and scientists are needed now.

Assignments are at HUNTSVILLE, CAPE CANAVERAL and DAYTONA BEACH

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If you have experience in any of the listed areas, write us today (include salary requirements). Your inquiry will be held in strict confidence. Write to: Mr. P. W. Christos, Professional Placement, Section 73-T, Apollo Support Department, General Electric Co., Support Building, Daytona Beach, Florida.

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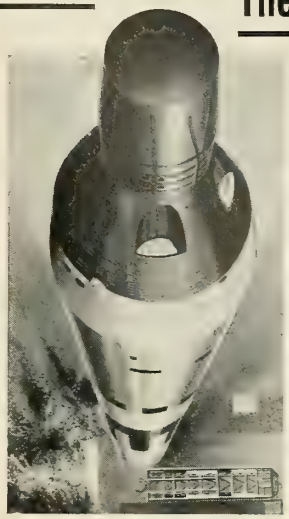
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This "Task Force" approach facilitates rapid build-up of engineering effort without re-organization or disruptive administrative changes. Since STD engineers operate in all company design areas, the organization provides an effective avenue for interchange of ideas and developments between all McDonnell engineering divisions.

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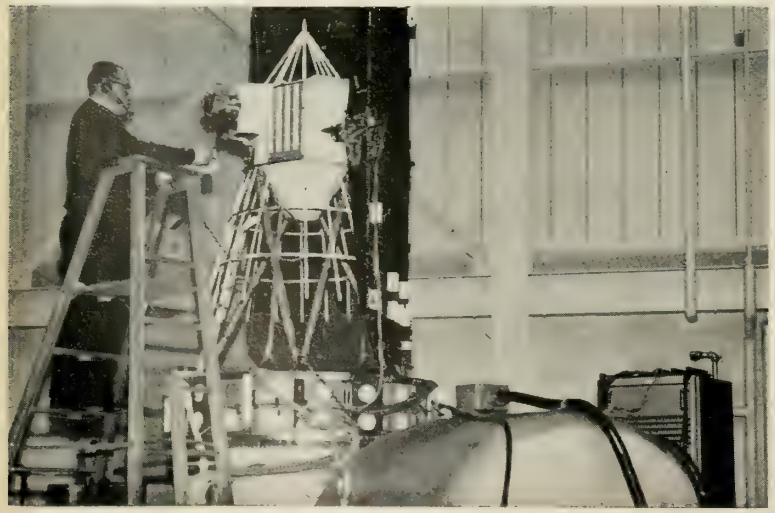




News in Pictures: Apollo and Nimbus

ABOVE LEFT: *Exclusive photo of Apollo Command Module with stabilizing strakes added (TECHNICAL COUNTDOWN, M/R, April 8, p. 21). Two narrow fiber glass fins were affixed high on the conical side of boilerplate module number six after reassessment of re-entry dynamics showed that the capsule could stabilize with its conical side forward. Heat shielding on the conical side is reported to be insufficient to withstand peak heating at lunar return velocity, and the Apollo astronauts are not positioned to endure the deceleration of re-entry in an apex-forward attitude. Addition of the strakes will make the capsule unstable in such in attitude, and atmospheric pressure will turn the capsule into the proper position—heat shield forward and crew facing opposite the direction of flight. Then the strakes will become ineffective in the wake of the capsule.*

ABOVE RIGHT: *Full-scale Apollo Command Module—instrumented to measure crew and structure g-loading—is drop-tested in new NASA test facility at North American Aviation, Downey, Calif. Nineteen tri-axial strain-gage accelerometers in capsule measure load-stroke stress on crew couch support structure, shock, travel, and load on struts, and general water-impact effects on dynamic stability. The 8500-lb. boilerplate capsule is dropped from a swinging pendulum at duplicate 18 mph speed and attitude of spacecraft as it will hit the water on returning from space.*



LEFT: *Vibration model of NASA's Nimbus meteorological satellite is shown in exclusive photo undergoing shaker tests at General Electric Co.'s Valley Forge (Pa.) Space Technology Center. Satellite is mounted on top of Agena adapter section that mates it to the Thor-Agena launch vehicle. GE reports that tests were carried out successfully. Vibrator operates to 2000 cps, with a 25,000-lb. peak vector sine force. A second vibrator of this type can be hooked up for tandem operation, doubling the peak force.*

Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand—getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at $\gamma = -6°$ to touchdown?

Curves Provide Key

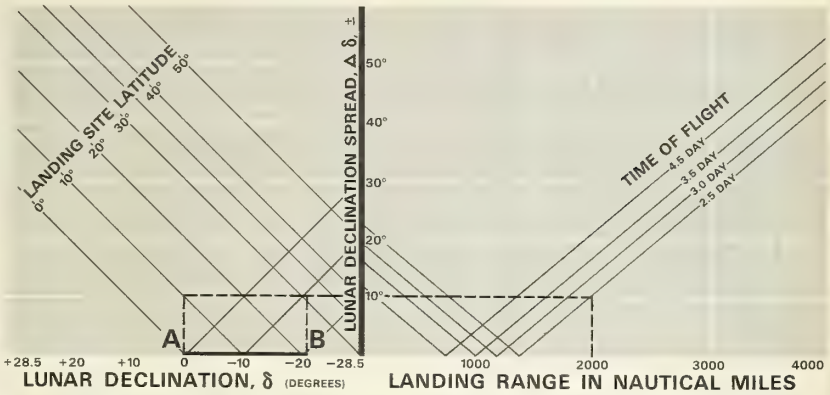
The curves at upper right provide the key. Window AB describes the range of lunar declinations, from $+0.5°$ to $-20.5°$, acceptable for returning to an earth landing site at a latitude of $+10°$, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at $\gamma = -6°$ to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of $-10°$. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

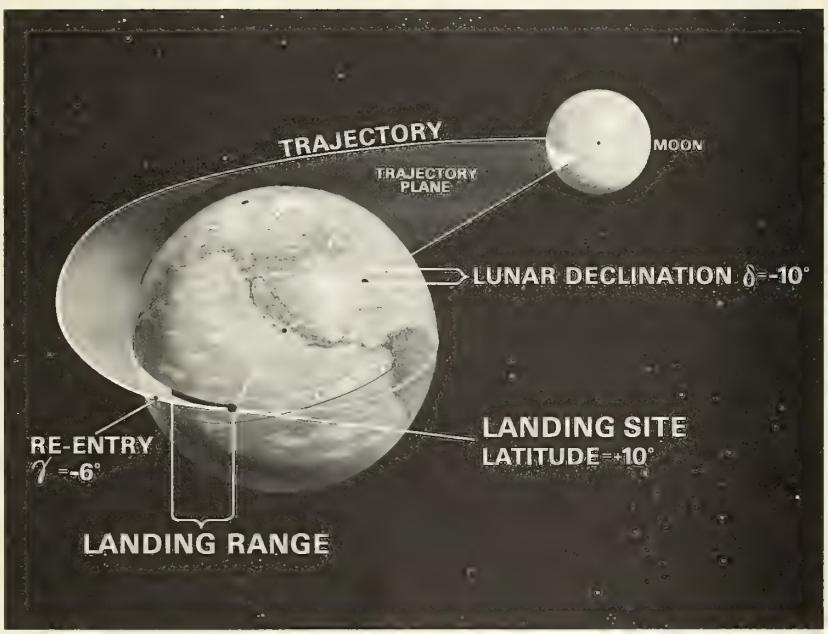
Variety of Opportunities

At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far-ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.

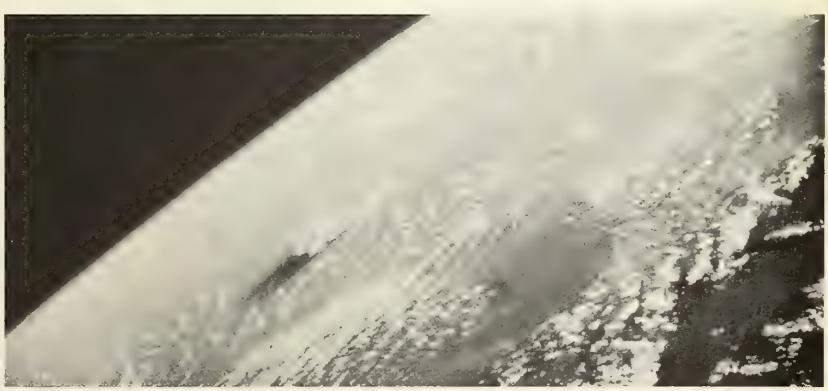
Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics|Astronautics, 5832 Kearny Villa Road, San Diego 12, Calif.





LUNAR LIFT OFF AT $\delta = -10°$ *Heading for an earth landing site latitude of $+10°$, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from $\gamma = -6°$ to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

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A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTISTS

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

INERTIAL GUIDANCE

BS degree in physics, EE or ME and 2 to 5 years of experience in one or more of the following:

TECHNICAL ANALYSIS: scope includes establishment of guidance and flight control system requirements, analysis of system performance, establishment of test parameters and initiation of design changes.

AUTOPILOT DESIGN: assist in the detail design and development of the Centaur space vehicle flight control system. The system includes the autopilot, programming devices, and passive tracking equipment. The designer is also responsible for design of necessary test equipment.

GUIDANCE SYSTEM: requires individual with design and fabrication experience for subcontractor control and to assure that the delivered guidance system is accurate and reliable. To achieve this goal, the tasks range from purest analytical study to configuration control.

DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability, or both.

Tasks involve TECHNIQUE DEVELOPMENT in the following:

SYSTEMS: User-Operations Analysis, Reliable System Design, System Reliability Models, Cost-Effectiveness Evaluation, Man-Machine System Analysis;

COMPONENTS: Reliable Hardware Design, Hardware Analytic Evaluation, Component Evaluation, Parts and Materials Selection, Specification Criteria, Supplier Programs and Evaluation.

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

EXPLORE THE IDEA of growth and advancement with one of the nation's prime aerospace firms, a company whose name is synonymous with leadership in a broad range of pace-setting industrial activities. Among dozens of active study contracts and in-process hardware projects which assure far-ranging challenges to Astronautics staff members are Nova, Centaur, Atlas SLV III, lunar vehicles, manned space stations, solar monitors and an impressive array of orbiting and space probe vehicles. Consider the scope of these projects. Match your interests and abilities with the activity descriptions at left. Visualize yourself at Astronautics, where the professional climate favors your career and the sunny San Diego climate favors your family's year-round enjoyment of life.



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Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, OPERATIONS AND SYSTEMS ANALYSIS, WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS AND CALIBRATION LABORATORIES, and TECHNICAL WRITING.

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Technical Countdown

ELECTRONICS

Passive Radar Suggested for Space Tracking

Ionospheric disturbances created by space vehicles or satellites may provide sufficient "passive" tracking data to obviate the need for conventional radar transmitters. The wake from vehicles in or beyond the ionosphere, claims Professor Floyd V. Schultz of Purdue University, leaves a void that, in turn, undergoes a short-term plasma oscillation. As a result, he says, electromagnetic waves are transmitted to earth that can be processed and followed electronically. Schultz reported these conclusions at last week's Magneto-hydrodynamics Symposium at the University of California, Berkeley.

Lasers to Microwaves Through Quartz

Scientists at the IBM Communications Systems Dept. are working on a technique for converting laser light beams to microwaves, using crystalline quartz and similar electro-optical materials. The customary method involves either phototubes or photoconductive devices. In the process, a ruby laser and a quartz crystal are coupled, producing an S-band microwave signal from two different frequencies in the laser beam. Conversion is accomplished through "reactive mixing," in which the intense laser beams change the index of refraction of the crystal, producing a microwave difference frequency. By locating the quartz within the ruby laser resonating system, and by coating the outer ends of both the crystal and the ruby with reflective material, output was enhanced to measureable levels. The laser emission is continually reflected back into the quartz crystal, IBM says.

Radio-Power Conversion Progresses

Conversion of microwave energy to direct-current electricity one day will be possible with efficiencies above 90%, say two Purdue University scientists. Professors R. H. George and E. M. Sabbagh recently reported obtaining usable power of up to 40 watts with efficiencies as high as 70%. Solid-state diodes were employed for rectification, with highly advanced circuitry, they said. (Best previously obtained, they pointed out, was 30%.) The two scientists consider development of a practical system to be ideal for supplying large amounts of power over long distances to spacecraft or space stations.

New Space Tracker Considered

Development of a half-mile-diameter multiple-plate antenna is being considered by the Air Force Cambridge Research Laboratories for very-long-range tracking. The quadra-ellipse configuration, according to Dr. A. Schell of AFCRL, will employ a 1000-ft. tower for the horn in the center of four petal-shaped plate patterns on the ground. Each petal, having a major diameter of 1200 ft., will contain 1200 movable plates. Designed for operation in the 400-3000-mc range, the radar would radiate with a one-minute beamwidth. (The system would be a more sophisticated version of the Soviet system at Pulkova Observatory, Leningrad. Used as a meridian transit for solar studies, the Russian antenna employs 100 movable plates and has a beamwidth of one degree by one minute.

System Automatically Guides Data Cameras

Douglas Aircraft Co. is perfecting a new system that will automatically guide data-gathering motion-picture cameras in following missiles in flight. Camera lock-on and control are achieved with a TV vidicon tube programmed to recognize signatures created by the missile's exhaust pattern. Movement of such a signature out of the target area on the vidicon activates servos which change the camera position. The system is being developed by the firm's Film Services Department, with systems engineering from the Missile and Space Systems Div.

Nimbus Referencing Systems to be Analyzed

The meteorological geographic referencing system to be developed for the *Nimbus* weather satellite will be analyzed under a NASA contract by Aracon Laboratories, a division of Allied Research Associates. The contract calls for a complete evaluation of the automatic data-processing/data-handling equipment to be integrated into the overall system. In addition, stand-by techniques, for use in the event of malfunction, will be studied. Geographic referencing involves pinpointing the exact location on Earth of photographs transmitted by the satellite.

ASTRONAUTICS

AEC Extends Hi-Altitude Wind Studies

Twenty-four sounding rockets will be launched from the Pacific Missile Range this year for the Atomic Energy Commission. Twelve will be fired in June, and 12 in September, to altitudes of 100 miles. Sodium vapor trails from four rockets per set of 12 will be photographed from ground installations at Kauai, Maui, and Hawaii. Eight of the rockets in each set will disperse metal chaff at altitudes up to 80 miles for PMR radar tracking. The tests, part of the high-altitude wind studies associated with AEC programs, is a U. S. project in the International Quiet Sun Year program.

Balloon Satellites Proposed

Air Force scientists are considering the use of balloon satellites for atmospheric studies. Up to fifty instrumented balloons of the super-pressure type could stay aloft indefinitely and provide a continuous view of the Earth's middle atmosphere, one AF official declares.

PROPULSION

Packaged Liquid Fired After Four-Year Storage

Thiokol's Reaction Motors Division fired an *LR44* packaged liquid engine after the unit had been stored for four years. The engine's performance was well within specification limits, with ignition interval, thrust and total impulse virtually the same as a factory-fresh unit. The engine was originally developed for the Navy's *Sparrow* missile and was stored fully loaded with liquid propellants and the solid pressurization grain. Intentional temperature changes varied between 120° and —37°F. with the former held for 16 months.

OAO Control System Tests Advance

Early checks at GE and Grumman highly encouraging; ground testing poses many problems; program growth seen

by Michael Getler

VALLEY FORGE, PA.—The stabilization and control network which will point the key optical experiments aboard the NASA-Grumman *Orbiting Astronomical Observatory (OAO)* scheduled for launching next year, has passed the first two important ground steps leading to flight qualification.

The first major test was made in December at General Electric's Space Technology Center here, where a pre-prototype (non-flight configuration) model of the S&C system was put through its paces in GE's 1-atmosphere *OAO* test facility. GE—which holds a major subcontract (valued at about $20 million) from Grumman for the S&C system—reports all ground-test performance specs were met.

Last month, results of the GE tests were partially verified as Grumman, with NASA looking on, began limited testing (also in a 1-atmosphere environment) of S&C capabilities in the initial Sun-stabilization mode. Though these early tests, made with first equipments delivered by the vendors, were of relatively short duration, Grumman engineers expressed a high degree of confidence in S&C system performance.

This week, Grumman has scheduled first "flights" of the system to begin checkout of the coarse-pointing mode, which requires ability to point the optical axis of the vehicle with an accuracy of ± 1 min of arc. and a drift of less than ± 15 sec of arc.

In June, Grumman is expected to begin vacuum chamber tests with the first flight-design prototype system, checking out operation through the final experiment-pointing mode calling for accuracies in space to 1/10 sec of arc.

● **Stiff ground problem**—For ground-testing, GE engineers point out that Sun-stabilization, coarse- and fine-pointing modes all must be demonstrated to the same accuracies as in space, with the exception of a relaxed requirement on the fine-pointing mode, which is reduced to 1 sec of arc (M/R, Dec. 4, 1961, p. 16).

In all, the S&C system involves 62 separate components; about half of these are pneumatic and half electronic. The GE contract extends through delivery of two flight units to Grumman in October and December of this year. An engineering model and a pre-prototype model were delivered last year, and the first flight-design prototype is slated for June delivery.

There is generally thought to be considerable room for growth in the *OAO* program, especially if the first flight is a success. Industry engineers feel that these craft with essentially the same structural and optical configuration may continue to fly through 1970. GE reports it hopes to bid shortly on three additional flight units.

Supporting GE as major electronic suppliers on the S&C system are: Kollsman Instrument Corp. (star trackers), Ball Brothers Research Corp. (Sun sensors), Telecomputing Corp. (phasolvers), GE's Light Military Electronics Dept. (digital logic unit), Bendix Eclipse-Pioneer Div. (inertia wheels), and Minneapolis-Honeywell (gyros).

Though the challenge of stabilization and control posed by *OAO* in space is certainly great, the requirements have also dealt some formidable problems to engineers trying to check system performance on the ground.

To cope with these, GE has poured about $2.5 million into a 24 x 24 x 40-ft-high *OAO* test facility. It assigned as many as 120 persons to work on a broad analysis of test problems and techniques late last year, when, GE engineers told M/R, there were still serious doubts as to whether meaningful ground tests could be made at all.

● **Balance critical**—The problem, essentially, was one of balance and the several physical relationships affecting it in a ground environment. In space, for example, the 2-in.-oz. fine control inertia wheels in the S&C system are used to counteract any opposing unbalanced torques on the vehicle. But in a 1-G ground environment, GE engineers explain, the system has to contend with the added disturbance torque arising from the air-bearing test table unbalance. This unbalance level has been specified as 0.2 in-oz, or 10% of that in a zero-g environment, which translates to a ± 10-deg attitude cone for the vehicle on the ground.

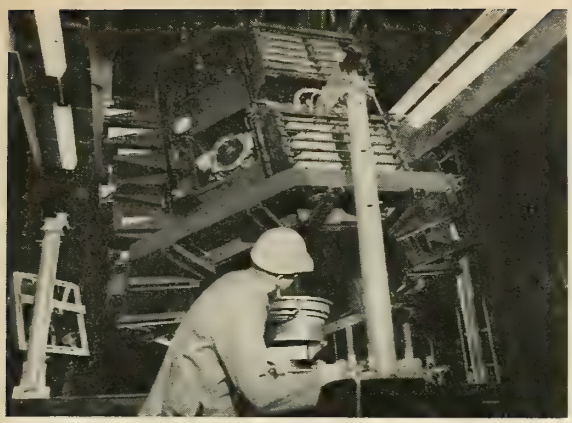
This means, says GE's manager of *OAO* systems evaluation, Jack Picard, that in a 1-g environment, the distance between the *OAO's* center of gravity (cg) and center of rotation (cr) has to be maintained at less than 11/1,000,000 of an inch.

GE attacked the situation from several angles.

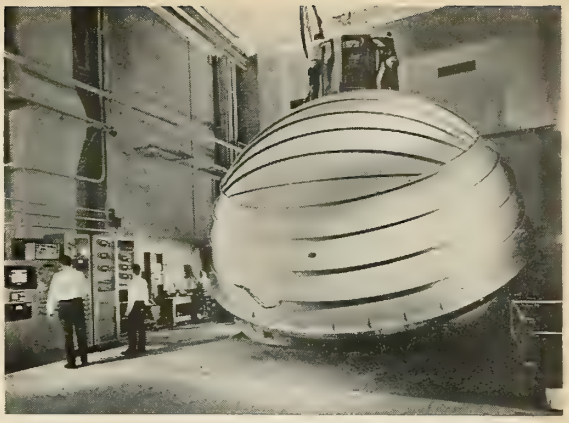
Initially, GE engineers report, certain inputs on the balance problem indicated that some perturbations which acted on the highly sensitive air-bearing platform could be removed by testing the system in a vacuum chamber rather than in the "closed-room" 1-atmosphere environment. GE constructed a 7000-lb. thermal model of *OAO*, and ran 24-hr. tests in both the 1-atmosphere facility and the vacuum chamber at the Space Technology Center.

"We could see no significant difference in operation between these two environments," says Picard. "The results were very similar, enough to keep us from going back into the chamber. Our 1-atmosphere facility is faster, less expensive to operate, and far easier to work in. We are convinced," he stresses, "that control system performance tests can be done in 1-atmosphere."

The firm is proceeding under the concept that a complete environmental check-out of all individual components, plus the 1-atmosphere system test, will



GE TECHNICIAN makes adjustment to OAO air-bearing test platform at Valley Forge. Four-ton structural model rests on 10-in. Invar ball. Posts are for chainomatic balance.



GRUMMAN ENGINEERS adjust solar simulator, part of firm's extensive vacuum chamber facility, which will be put to full use this June in OAO environmental checkout flights.

provide a high level of confidence to Grumman and NASA that the system will perform as required in final environmental tests at Bethpage.

GE also developed an 8100-lb. octagonal model of *OAO* which matched the vehicle's moments of inertia, but was considerably smaller in size and denser than the actual flight model of *OAO*, which will weigh about 3600 lbs.

In the test facility, this model rests on the air-bearing platform which is supported by a 10-in. Invar ball. The material was chosen due to its low coefficient of thermal expansion which also introduced improved thermal stability into the test complex. GE determined that the sphericity of this ball, considered extremely small to lift the 4-ton model, could not change more than 30-millionths of an inch during operation without aggravating the balance problem. New instruments had to be developed, they claim, to measure this change.

The ball rests on a dry-nitrogen air bearing, fed at 350 psi through a multi-orifice system which Picard feels also may contribute to improved platform stability over single-orifice devices. There is a 1-mil clearance between the ball and the gas outlets.

● **Chainomatic balance**—To actually balance the model within torque limits on the platform prior to turning on the S&C system, GE has put into operation a coarse and fine balance system which effectively reduces the period of oscillation of the vehicle at a considerable saving in time.

Initial design of S&C system, they report, allowed the cg and cr to be brought with 0.3 in. of each other. To move within the ground-test tolerances, coarse corrections are first made manually on the test model by means of a string of compensating weights hung externally along all three axes. Following this, personnel are removed from the test area and the final fine balance is made remotely from a control console by highly skilled operators who edge three 4-5 oz. weights gradually toward achieving the balance.

For this balancing operation, GE has also newly applied the rather ancient technique of chain balancing, coming up with a system which they claim reduces by a factor of 10 the time it normally takes for the horizontal balance determination which is made just prior to end during the fine balancing stages of the operation.

The GE "chainomatic balance system" involves eight lightweight silver chains which are attached at one end to points on the spacecraft model and at the other to four posts surrounding the platform. In effect, these chains introduce a known damping force which reduces the period of a ± 1-deg peak-to-peak oscillation from 30-40 min., common with use of pendulum-motion timing systems, to about 3½ min.

A direct vehicle unbalance readout is provided on a strip chart recorder by using a GE-developed position-and-rate-sensing system with a ± 45-deg range in pitch and yaw, accurate to approximately 3 arc minutes; and a 360-deg roll range, accurate to less than one arc minute. Backing up this system as a cross-check are a series of capacitance gages.

GE reports it can now balance the 8100-lb. model in about 2-3 hrs. Engineers report they are about two or three months away from a fully automated balancing scheme for the facility which may cut this time in half—and be inherently more stable by totally removing the human from the chamber, thereby reducing still further problems which stem from seemingly insignificant imbalance in room environment.

To observe the attitude of the test vehicle during S&C system tests, and also as a possible back-up during the fine balance operation, GE uses three autocollimators modified by Barnes Engineering Corp. specifically for the *OAO* test facility. It's reported that these provide analog readout over a 15-arc-minute range with accuracies from less than 1 arc sec. to 6 arc secs. These remotely operated devices went into operation last week.

● **Thermal instabilities**—Moving the *OAO* stabilization and control problem out of the zero-g space environment into ground facilities for test also greatly complicated the job of solving operating-component thermal problems contributing to vehicle unbalance. *OAO* heat dissipation, GE says, approaches 1 kw. As components heat up after turn-on, they expand, again causing cg shifts.

GE undertook a study, which is still going on, to determine the contribution of each component to system unbalance. The nickel-cadmium batteries were found to introduce a large portion of the thermal instability. Using techniques first developed by the firm during re-entry heat shield work, GE preheated the S&C electronics prior to turn on to the nominal temperature to which they would rise, about 100° F.

Then, Picard reports, "We removed the external heat, turned on the electronics and witnessed a modest fluctuation for about 30 minutes which could be compensated for by the fine balance system." The system then "evened out, with no major thermal consideration in the unbalance problem." GE will move the study into rotating components as the next phase.

Also included in the GE facility are three stellar simulators able to duplicate — 2 to + 2 magnitude stars. The light output of these devices is collimated to less than 2 arc secs., with a folded optics system cutting down significantly on focal length and size of the simulators. ■

missiles and rockets special repor

Advertising Closing Date: May 6
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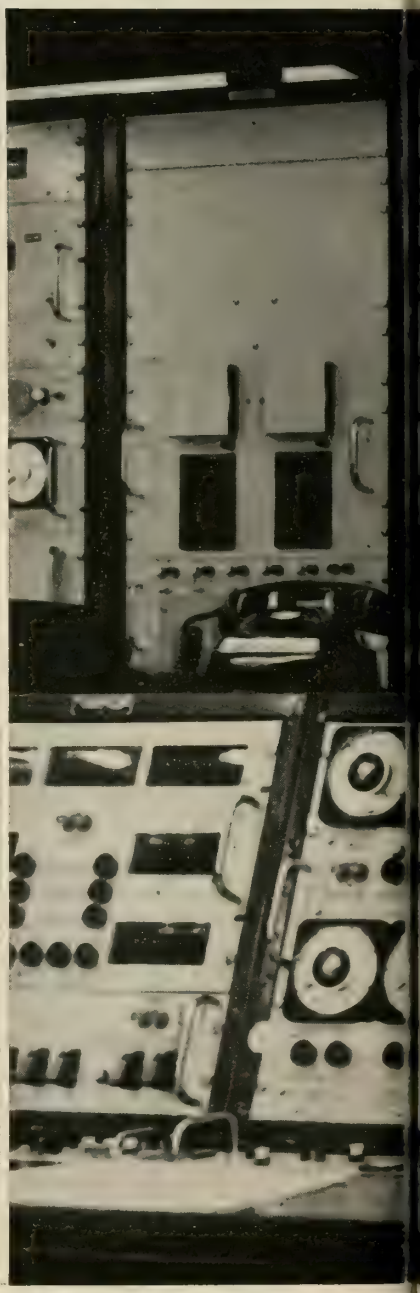
On May 20, MISSILES AND ROCKETS will publish its Special Electronic Report covering Test and Checkout equipment.

As the state-of-the-art advances, Test and Checkout equipment becomes even more important to future space successes. During the past year there have been dramatic advances in this area but much remains to be done by industry and government.

MISSILES AND ROCKETS, the Weekly of Space Systems Engineering, will provide in-depth reports on . . .

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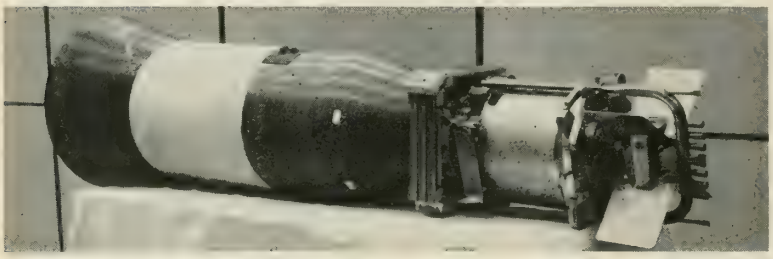
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SNAP Mockup To Burn Up in Re-entry

AEC shot with NASA Scout is part of series of non-nuclear flights to evaluate system's safety; rods will carry tracer



RE-ENTRY VEHICLE for AEC Re-entry Flight Demonstration-1 (RFD-1), with mockup of non-radioactive space reactor at right. Fins would dissipate heat from coolant-circulating pump in an operating reactor. RFD-1 will gather data on how a space reactor should be designed so that it will break up and disintegrate upon re-entry. Vehicle was built by Sandia Corp., AEC's prime contractor for RFD.

THE ATOMIC Energy Commission will attempt to determine this week whether nuclear space reactors can be safely destroyed during re-entry into the atmosphere.

The information will be obtained when a mockup of a reactor is deliberately broken apart following an 800-mi. ballistic flight from the Wallops Is., Va., launch facility.

The SNAP-10A type reactor, together with an instrumented re-entry vehicle, was scheduled to be launched by a NASA *Scout* booster no earlier than April 15.

Designated Re-Entry Flight Demonstration-1 (RFD-1) the flight is one of a series of non-nuclear tests to evaluate the safety of SNAP aerospace nuclear power systems in operation. Three tests are planned over the next two years.

• **Planned burn-up**—A number of non-radioactive test fuel rods, loaded with tracer material, will be mounted on the re-entry vehicle. Telemetry equipment in the re-entry vehicle will broadcast the complete sequence of the test. The test package, including the reactor, fuel rods and associated equipment, will weigh about 400 lbs.

The planned RFD-1 trajectory passes about 125 miles southwest of Bermuda. As the re-entry vehicle comes within optical tracking sight of Bermuda, it is expected that the dummy fuel rods will be ejected, the reactor will break apart and all the components will be subjected to re-entry heating. Viewing of the fuel rod burn-up will be aided by the burning of the tracer material. This will produce a colored glow for about 300 seconds that may be visible to the human eye.

The Sandia Corporation, Albuquerque, N. M., is AEC's prime contractor for the RFD-1. Atomics International, Canoga Park, Calif., AEC's prime contractor for SNAP reactors, built the reactor mockup.

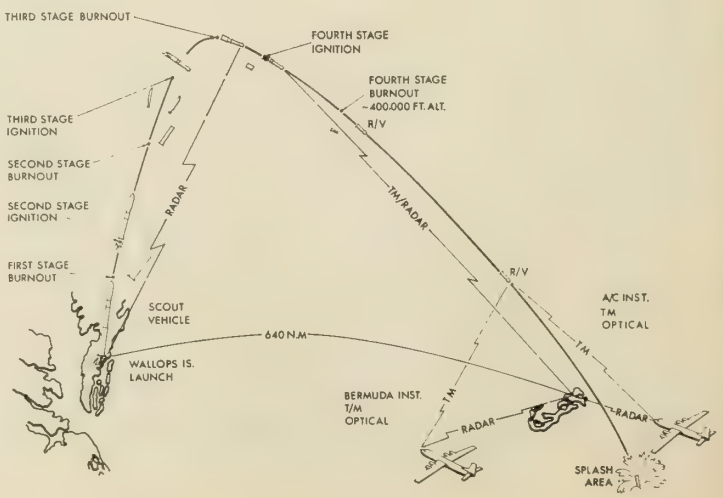
Development of safety features is a major phase of AEC's SNAP (Systems for Nuclear Auxiliary Power) program.

The goal is design of devices which will operate at desired power levels in space without presenting a radiation hazard to the Earth's population. To reach this goal, it is necessary to get test data on the energy (heat) resulting from the re-entry friction of a space device and its effect on the device.

Under certain conditions, reactors will be designed to break apart and burn up at high altitudes. The residue—very minute particles—will be dispersed to very low concentrations of radioactivity by atmospheric currents at high altitudes before falling to Earth.

• **Tracking**—The optical tracking instruments will be located on the High Point Station in Southampton Parish on the southern extremity of Bermuda. They will include one fixed and one tracking telescope, each with a 24-in.-dia., 120-in.-focal-length mirror, and one tracking telescope with a 16-in.-dia., 120-in.-focal-length mirror. The tracking telescopes will be mounted on hydraulically operated turrets.

The U. S. Air Force Special Weapons Center (AFSWC) at Kirtland AFB, Albuquerque, N. M., will provide two aircraft for optical tracking and the U. S. Air Force Systems Command will provide one aircraft and a telemetry ship for recording the re-entry. ■



SANDIA ARTIST'S DRAWING of planned trajectory for RFD-1 flight.

Systems Engineers...

some plain talk about ground floor openings at Honeywell

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Decision-Making: Logistics Support... What, Where, When?

Centuries ago the critical factor in logistics support was providing basic supplies—food, armaments, raw materials for simple industries. A few decades ago, carrying capacity—sea and land transportation—ruled as the decisive element. Within the last decade, a new critical element in logistics support has emerged. It has been created by the complex, interfacing governmental, industrial and military structure of today. This new factor is up-to-the-minute information—gathered from afar, varied in content, immense in volume.

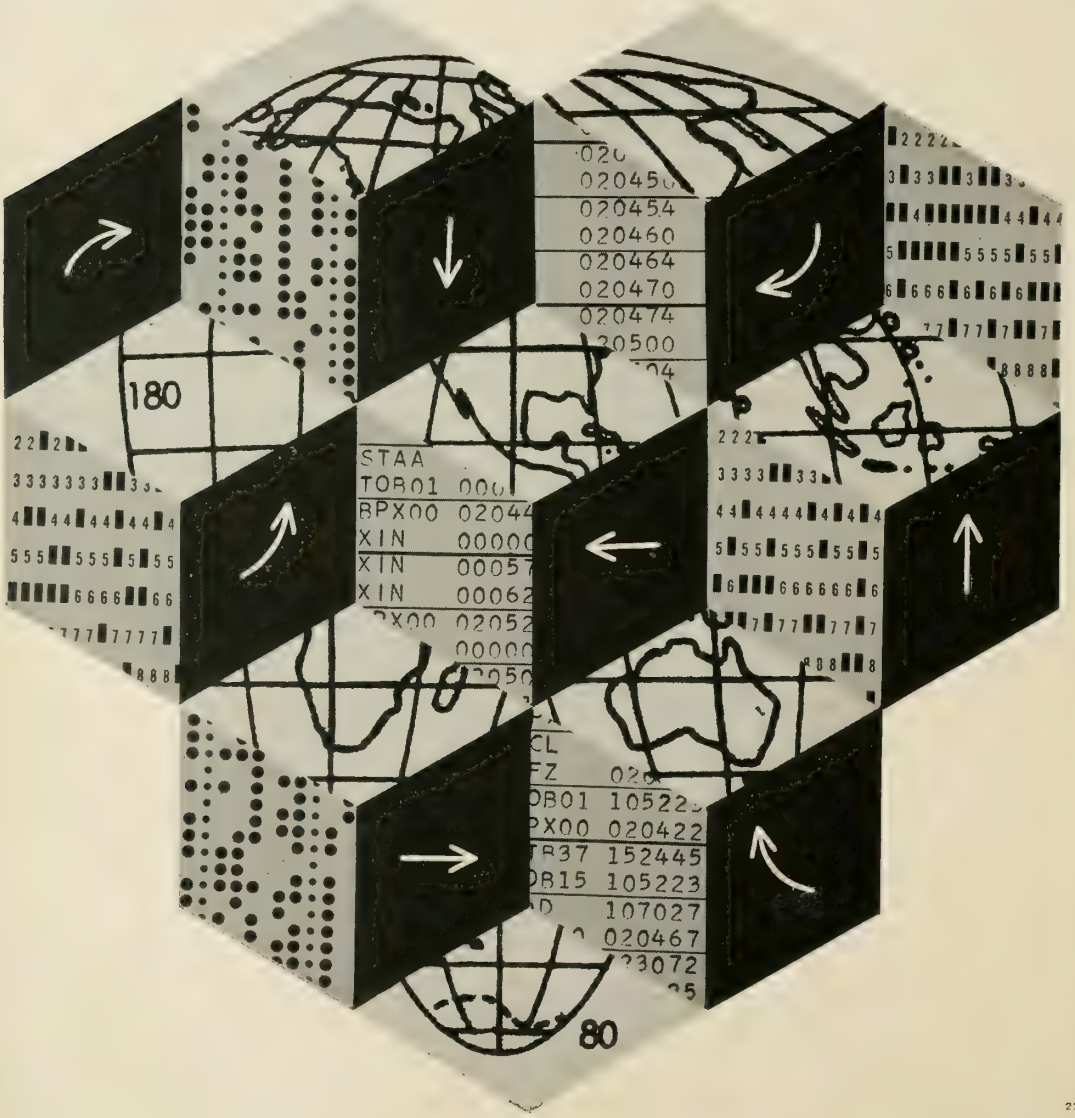
To help provide and control this flow of information, SDC scientists, and engineers have helped create a new technology: information systems which aid managers in determining the "what, where and when" of logistics support for world-wide and continental activities and forces.

In developing these systems which provide information processing assistance, SDC scientists and engineers have evolved an interdisciplinary approach. Teams of operations research scientists, engineers, computer programmers and human factors scientists work together in these major system development steps: analyzing the system, synthesizing the system, instructing computers within the system, training the system, evaluating the system—and helping adapt the system to the changing needs of its users.

Scientists and engineers interested in joining this growing field are invited to write Dr. H. H. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Massachusetts; Paramus, New Jersey; Dayton, Ohio. "An equal opportunity employer"

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21-901

Grumman Tries to Break 4-rpm 'Limit'

Experiments are aimed at making it possible for astronauts to live comfortably in space stations rotating as fast as 8 rpm's

by Heather M. David

BETHPAGE, L.I., N.Y.—Scientists at the Grumman Aircraft Engineering Corp. are trying to devise a means for astronauts to live comfortably in rotating space stations.

Dr. Bill Wenzel and Dr. Joe Liss suspect that men can live without nausea in capsules that rotate faster than generally accepted limits now allow. If this is true, space stations of significantly smaller diameter—with correspondingly higher rotation rates to provide artifical gravity—could result.

It also would mean that artifical-g space stations would not have to wait for the giant boosters. Thus, long-duration sojourns—three months or more—could be planned earlier without risking detrimental weightlessness effects.

• **4-rpm limit held**—Current literature holds that the human upper velocity limit is 4 rpm. However, Grumman engineers suspect that men can be comfortable for long periods at 8 rpm, if the radius from the hub is about 50 ft.

Figures show that quite drastic reductions in size can be effected if the rpm can be increased: At 4 rpm, to produce 1 g, a hexagonally shaped space station would have to be 200 ft. in dia. At the same rpm, to produce only 0.4 g, it would have to be 75 ft.

This space station would require a *Saturn C-5* to boost. But, at 8 rpm, producing 1 g, a space station would only have to be 50 ft. in dia., requiring only a *Saturn C-1B* booster.

Grumman researchers feel that avoidance of certain movements will enable men to live normally at 8 rpm without becoming nauseated. They dispute the 4-rpm limit because existing research facilities are not suitable for space station extrapolation, they say.

For instance, the Pensacola slow-rotation room in which the 4-rpm limit was set had these drawbacks:

—1) centrifugal and gravitational accelerations were perpendicular (the floor was flat).

—2) resultant force on a stationary man was not perpendicular to the floor.

—3) walking produced a change in radius.

(These three factors alone amplify motion sickness, since they create instability and increase head movements.)

—4) The radius was small. (Because centrifugal force of a space station will be greater at the larger radius, the man's stability should be improved, resulting in a decrease in his head movements).

—5) The visual field included the center of rotation and the opposite side of the room. Because the subjects could see others on the other side of the room moving in opposite directions, it may have been upsetting.

• **Grumman experiment**—The 20-ft.—radius centrifuge upon which space station experiments are being done has two hinges where the cab can be placed. These hinges, one at 3 ft. and one at 15 ft., will aid in determining the effect of radius on motion sickness at the same rpm.

The cab is actually a small room measuring 10 ft. x 8 ft. x 8 ft. It is large enough to permit installation of a bunk-bed, control panels and other equipment roughly simulating space station opera-

Edible Space Station Material Developed

"Man, it sure doesn't *taste* like fibreboard!"

A unique blend of space station construction and food supply has been developed by a Grumman scientist who bought all his supplies at a local supermarket.

Called ESM (Edible Structure Material), and made solely from organic substances, it emerges after pressure-heating looking much like fibreboard.

ESM is slightly harder than Fibreboard (compressive strength is 7230 psi and can be improved); it has about the same weight (0.049 lbs. per cu. in.); and it can be used for much the same uses. But there the resemblance stops.

Unlike fibreboard, it has 300-400 calories per 100 grams and can be ground up or soaked for 24 hours to make a cereal to be eaten in emergency conditions.

The material contains hominy grits, powdered milk, cornstarch, flour and powdered banana flakes. It is heated around 300°F at 3000 lbs. psi for 5-10 min. until the sugars and milk powder flow and form a matrix.

When molded in sheets and covered with a removable film laminate of Mylar, aluminum foil and polyethelene, ESM can be used for such secondary structures in space stations as instrument panels, bunks, clipboards, internal sheathing and walls, packaging and compartment dividers.

The material holds screws and nails, has no known low-temperature limit (although it will char at about 250°F) and—with its covering—would be waterproof and insect proof. Therefore, ESM should last indefinitely, says its originator, Dr. Sydney Schwarz.

In its present makeup, ESM is said to taste like a banana-flavored cereal. Other flavoring and vitamins added to the formula would not change its properties. Schwarz, adding: "With sugar and cream it's delicious—but then anything is!"

Schwarz, who is Grumman's chief physiologist for the *Lunar Excursion Module*, doesn't suggest that the material be used as a main food supply. But, he points out that it would reduce backup supplies "by about 90%."

A patent is being applied for, Schwarz says.

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Actually, at any point in time, FEC engineers and technicians are working on more than 100 active projects—installing, testing or operating almost every type of wire or wireless communication system in addition to radar, instrumentation and computer facilities, plus the multitude of ancillary systems and services supporting them.

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There are always interesting positions at many levels with FEC. However, openings change from day to day. If you would like to receive further information on current opportunities, please write to: Mr. A. Sheridan, ITT—Federal Electric Corp. Room 77-WN, Paramus Industrial Park, Paramus, N. J.

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tion. The seat can be locked in several positions.

What makes the unit unique is the fact that the cab sides can be tilted to any desired angle for each run. By tilting the cab, the researchers say, the effort of walking while the room is being rotated is reduced greatly. It more closely simulates the angle of force which would occur in a rotating space station free of the Earth's gravity.

The first phase of the Grumman project has been to pin down what head movements, coupled with coriolis force, cause nausea and disorientation. This combination of forces is called gyroscopic coupling.

Three kinds of angular motions of the head were investigated with the floor flat—rotation, nodding and cocking. Undesired stimulation was experienced in nodding and cocking, but not in rotation.

In the space station simulator (floor tilted), stimulation occurred in rotation and cocking, but not nodding. The stimulation resulted in one of two things: 1) instantaneous nausea if disturbance of head was of a large magnitude, or 2) illusions, in which the visual field appeared to move about the third axis. In time, these illusions apparently can be adapted to, and they eventually disappear. However, there is little adaptation to the stimulation which results in nausea.

The Grumman group is trying to determine by mathematical means what values of these components cause undesirable stimulations.

● **Space station design**—In the second phase of the program, now beginning, the subjects are walking about the room and performing the types of duty required of astronauts.

Eventually, behavioral patterns and arrangement for cabin interiors geared to minimizing stimulations will be worked out.

Movements in the space station would be designed to avoid any rotation or cocking of the head. The Grumman researchers say one way to accomplish this would be to always walk in the same direction. They feel that it would be desirable to walk against the spin of the capsule, since the astronaut's weight would increase according to the rate of walking if in the direction of the spin. Another maneuver which might minimize the chance of nausea would be for the astronaut to back up for short distances rather than turning around.

Control panels probably will be arranged vertically, so that the astronaut would look up and down rather than turn his head to the side. When he does turn, he probably will do well if he freezes his head to his body, and turns somewhat like Frankenstein's monster, they say. ■

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ABOVE: *Mosquitoes mounted on cross-country Puch-Haflinger vehicle, ready for firing. Mosquito is also launched from armored vehicles and helicopters.* **RIGHT:** *Mosquito container holds one missile with mounted wings. Only the head has to be attached, allowing immediate readiness. System is only antitank missile which can be recovered for training purposes. Recovery is effected by parachute ejected upon a signal from operator. Same missile is used for several flights, reducing costs.*

international

Output of Antitank Mosquito Climbs

ZURICH, SWITZERLAND—The Contraves *Mosquito* antitank missile, recoverable in training and available to all nations, is currently being produced by some 1300 workers in Switzerland and an additional 800 in Italy.

The wire-guided surface-to-surface weapon was developed at Contraves' facilities on the outskirts of Zurich, but production takes place at both the Swiss plant and the Rome factory of the company's Italian subsidiary, Contraves Italiana.

About 2000 missiles were built under development programs before the *Mosquito* went into full production in 1961; since that time, some 3000 have been turned out, most of them in Switzerland. Italian output is slowly building up, and total monthly production from plants in both countries now numbers several hundred units.

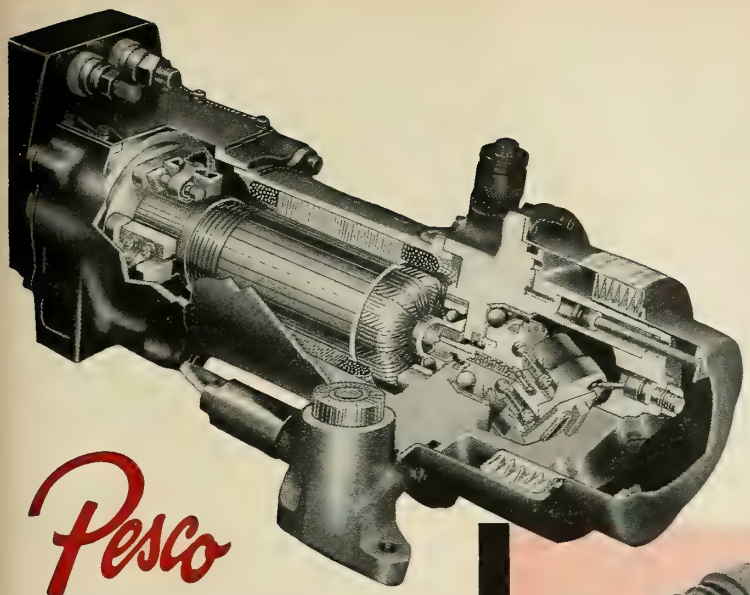
Contraves sales executives expect the *Mosquito* to remain in production for at least three more years. They believe that total sales will reach at least 30,000 to 40,000—The later figure, incidentally,

Mosquito Specs

OVERALL WEIGHTS	
Mosquito complete with warhead	27.6 lbs.
Control box	1.76 lbs.
Combat carrying container including one complete Mosquito with detached head	33.7 lbs.
DIMENSIONS	
Length	43.7 in.
Wingspan	23.6 in.
Diameter of body	4.7 in.
Dimensions of detachable wings	9.4 x 12.6 in.
Combat carrying container	17.7 x 17.7 x 29.5 in.
PERFORMANCE	
Launching acceleration for approx. 0.8 sec.	13 g
Flight velocity	300 ft./sec.
Maximum range	6000 ft.
HOLLOW CHARGE WARHEAD	
Total weight	7.3 lbs.
Diameter of shell	4.7 in.
Weight of explosive	4 lbs.
Penetrating power on armor plate	over 24 in.
Minimum impact angle of fuse	15 deg

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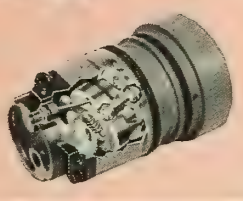


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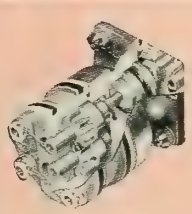
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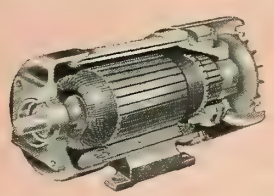
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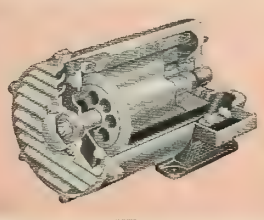
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will represent the break-even point of the project, including development costs.

● **Selling points**—There are several reasons for Contraves' optimism about sales prospects. The missile is completely unclassified—any army can buy it. It is quickly available—deliveries of both the *Mosquito* and its training simulator can be made within a few months of ordering.

It is not expensive—for a small batch of less than one thousand, the unit price is below $1000. And, unlike its competitors, it is recoverable—a parachute-head training version makes this possible. Three heads, all interchangeable, are available—warhead, dummy head and parachute head.

An unusual feature of *Mosquito* is that the four honeycomb wings are detachable. Normally they are only attached to the cylindrical fiber glass body just prior to use.

Control of *Mosquito* is effected by a vibrating spoiler in each wing's trailing edge. A two-stage solid-propellant powerplant is used. The roll-stabilizing gyro is started by powder explosion.

Contraves is proud of the fact that all components of the missile except transistors are manufactured in Switzerland or license-built in Italy. ■



ASSEMBLY LINE for cabling at Contraves Mosquito plant in Zurich.

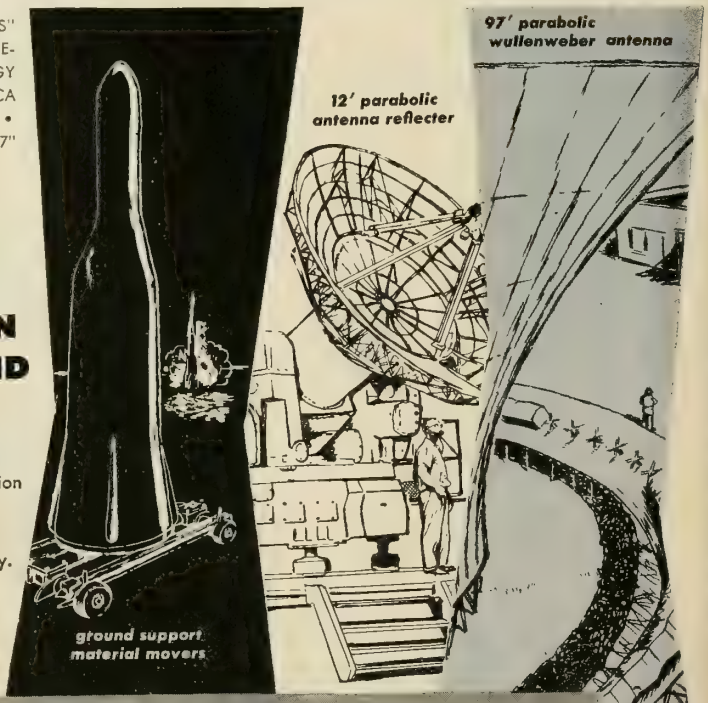
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ENGINEERS FABRICATORS

Representatives Named

Poly-Onics, Inc., Leawood, Kan., has been appointed Midwestern representative of Computer Measurements Co., San Fernando, Calif. A division of Pacific Industries, Computer Measurements manufacturers solid-state and vacuum-tube digital instrumentation. . . . *Compar Corp. of Burlingame, Calif., has been named national sales representative for Signets Corp., Sunnyvale, Calif., manufacturer of electronic integrated circuits. Two areas of the U.S. will not be affected by the change: Florida and Northern California-Seattle. Gulf Engineering Sales of Orlando and Engineering Liaison Associates, North, of Redwood City will continue to represent Signets in these areas.* . . . P.B. Associates of Orlando, Fla., now is exclusive Florida representative for Fluid Dynamics, Inc. Fluid Dynamics manufactures high-specific-performance filters. . . . MB Electronics, New Haven, Conn., will handle U.S. sales and service of the Dutch-manufactured Peekel Electronics line of strain-measuring instruments. The Peekel instruments have applications in environmental test laboratories, and are considered a complement to the line of vibration test equipment and instrumentation manufactured by MB. . . . *Ossmann Instruments, Inc., has been named up-state N.Y. sales representative for the Narda Microwave Corp. of Plainview, N.Y. Ossmann has offices in Syracuse, Rochester, and Vestel.* . . . Chicago Bridge and Iron Company has arranged to acquire from the A. O. Smith Corporation exclusive rights to manufacture and sell MULTI-LAYER vessels and cylinders in the U.S. and Canada. CBI is buying from Smith the necessary patents and equipment, and transfer of Smith machinery to CBI's Chicago plant is under way. . . . *Arco Electronics, Inc., Great Neck, N.Y., national marketing agency for Elmenco dipped mica, silvered mica, and dipped mylar capacitors, has appointed seven new master industrial distributors. They are: Allied Electronics, Chicago; Kierulff Electronics Corp., Los Angeles; Electrical Supply Corp., Cambridge, Mass.; Hammond Electronics, Inc., Orlando, Fla.; M. G. Electronics & Equipment Co., Inc., Birmingham, Ala.; Electronics Wholesalers, Huntsville, Ala.; and Electronic Material Sales Co., Dayton, Ohio.*

New Firms and Divisions

Lotepro Corp. has established offices in New York City. The firm, headed by president Dr. C. F. Rumscheidt and associates Walter Linde and E. G. Hernried, supplies cryogenic equipment and plants for the metallurgical, nuclear and petrochemical industries, in the areas of gas separation, purification, upgrading, liquefaction and storage. It is associated with Linde A. G. Munich, Germany, manufacturer of low-temperature equipment. . . . *Pennsylvania Optical Co., optical component manufacturer, has set up a Precision Optics Div. to handle exacting industrial or military precision lens requirements. T. J. Glembocki will manage the new division.* . . . United Aircraft Corp.'s Hamilton Standard Div. has established a Space and Life Systems Dept. Work on the *Apollo* space suit, the environmental control system for the Lunar Excursion Module, and several other NASA-funded bioscientific programs will be consolidated within the new department. . . . *Fairchild Space and Defense Systems (FSDS) is the new name of Fairchild Camera and Instrument Corp.'s Defense Products Div. at Syosset, N.Y., and at Los Angeles and Palo Alto, Calif. FSDS will produce visual-imaging and data-handling systems for aerospace optical and mechanical equipment and other applications.* . . . Kaman Aircraft Corp., Bloomfield, Conn., has established a new Electronics Systems Div. to direct the firm's efforts toward design, development, and manufacture of complete electronics systems, specializing in space and airborne applications. . . . *Guidance Technology, Inc., Santa Monica, Calif., has applied to a Federal District Court in Los Angeles for reorganization of the company. GTI, a subcontractor in the Terrier, Tartar and Bullpup programs, has Air Force funds for continued operations—related to certain defense programs—pending the contemplated reorganization. GTI has been operating in recent months with assistance of a voluntary creditors committee.* . . . North American Aviation's Autonetics Div., Anaheim, Calif., has formed an Advanced Engineering Dept. within its Armament Control Product Div., increasing emphasis on radar research and systems development. The new department will develop navigational and armament-control radar engineering applications, and will seek to increase Armament Control's capabilities in microminiature radar electronics and coherent and non-coherent data-processing systems. . . . *Ford Motor Company, Dearborn, Mich., has established a Special Projects Section to concentrate on creation of new concepts for combat, tactical and missile ground support equipment.* . . . Microphysics, Inc., a new company devoted to the application of microminiature techniques to military and electronic items as well as industrial and consumer products, has been formed in Huntington, N.Y. The company's first efforts will be devoted to products for industrial, electronic and aerospace applications in the fields of micromechanisms, microoptics, microkinematics, and microdynamics. . . . *Bendix Balzers, Inc., jointly owned by The Bendix Corp. and Balzers A.G., Switzerland, has been formed in Delaware to design, build, and sell high-vacuum equipment for the scientific, industrial, and commercial fields. The new firm is part of a broad Bendix expansion program in advanced scientific equipment.*



Photo by Reeves Instrument Corporation
Garden City, New York

Inland Gearless Torquers give 2-axis precision to Reeves Radar Pedestals

Precision Radar Pedestals . . . manufactured by Reeves Instrument Corporation, Subsidiary of Dynamics Corporation of America . . . play vital roles in major satellite and missile programs. Designed to accommodate reflectors up to 30-feet in diameter, they feature 5-second angular accuracy, azimuth load bearing ratings at 250,000 pounds and tracking rates from zero to 10 rpm in azimuth and from zero to 1/2 radian/second in elevation.

Accurate 2-axis servo-positioning of these Reeves Pedestals is effected by Inland Gearless Torquers ranging in torque output from 500 to 3,000 pound-feet.

Fast, high-resolution response to servo-position error signals is a major reason why Inland Gearless Torquers win so many missile and space-vehicle assignments. The superior performance of these direct-drive d-c torque motors comes from torque-to-inertia ratios 10 times higher than equivalent gear-train servo motors. Moreover, their compact pancake configuration meets space and weight restrictions.

What's your problem? If you're currently planning a servo system calling for output torque between 20 ounce-inches and 3000 pound-feet*, compare Inland Gearless Torquers with any alternative. Write for all the facts today, 347 King Street, Northampton, Massachusetts.

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contracts

AWARDS

AIR FORCE

$6,200,000—**International Telephone and Telegraph Corp.,** Paramus, N. J., for continued work on a classified communications project.

$4,300,000—**Hughes Aircraft Co.,** Culver City, Calif., for continued research and development on *Falcon* missile fire control system.

$2,900,000—**General Dynamics Corp.,** San Diego, Calif., for continued research, development, technology and engineering on a space launch system.

$2,896,883—**Illinois Institute of Technology, Armour Research Foundation,** Chicago, for re-establishment and operation of an electromagnetic compatibility analysis center at Annapolis, Md.

$2,634,000—**Martin Marietta Corp.,** New York City, for activation of the *Titan* missile base at Lowry AFB, Denver.

$2,500,000—**Sperry Rand Corp.,** New York City, for instrumentation of C-4 tracking vessels for the Atlantic Missile Range.

$2,261,904—**Philco Corp.,** Philadelphia, for work on control subsystems for space programs.

$2,000,000—**Aerojet-General Corp.,** Azusa, Calif., for development and fabricatoin of a *Titan II* propulsion system for the *Gemini* program.

$2,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space vehicles. Work to be done at Sunnyvale, Calif.

$1,800,000—**Ralph M. Parsons Co.,** Los Angeles, for *Titan II* missile base trainers.

$1,600,000—**Loran Electronics Corp.,** New York City, for classified electronics equipment.

$1,500,000—**North American Aviation, Inc.,** El Segundo, Calif., for work on *Hound Dog* weapon system.

$1,400,000—**Space Technology Labs,** Redondo Beach, Calif., for space program work.

$1,200,000—**Avco Corp.,** Wilmington, Mass., for re-entry technology and systems evaluation.

$1,100,000—**General Precision, Inc.,** Little Falls, N. Y., for compass system spare parts and equipment.

$1,009,384—**Lear Siegler, Inc.,** Santa Monica, Calif., for production of components of the automatic flight subsystem for the *Q2-C* drone.

$1,000,000—**General Electric Co.,** Philadelphia, for work on *Titan II* re-entry vehicle.

ARMY

$6,500,000—**General Electric Co.,** Syracuse, N. Y., for *Nike-Hercules* high-power acquisition radar.

$5,597,220—**Thiokol Chemical Corp.,** Bristol, Pa., for *Sergeant* missile motors and renovation of hand-held signal flares.

$5,000,000—**Aerojet-General Corp.,** Downey, Calif., for an *SD-2* drone system.

$4,409,384—**Aerojet-General Corp.,** Sacramento, Calif., for 1988 rocket motors for the *Hawk* missile system.

$4,127,123—**Firestone Tire and Rubber Co.,** Akron, Ohio, for classified work.

$2,600,000—**Western Electric Co.,** New York City, for *Nike-Hercules* equipment.



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$2,303,472—**Mason & Hanger-Silas Mason Co., Inc.,** New York City, for *Nike-Hercules* and *Hawk* warheads and various types of ammunition.

$2,285,051—**Holston Defense Corp.,** Kingsport, Tenn., for miscellaneous types of propellants and explosives.

$1,999,618—**Collins Radio Co.,** Cedar Rapids, Iowa, for *Sergeant* missile fuzes.

$1,400,000—**University of Illinois,** Urbana, Ill., for electronics research.

$1,032,000—**Philco Corp.,** Philadelphia, for *Sergeant* missile fuzes.

$535,500—**Brunson Instrument Co.,** Kansas City, Mo., for production of theodolites.

NAVY

$5,777,886—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for production of *Polaris* missiles and sustaining engineering services on the missile system.

$4,100,000—**Litton Industries, Inc., Litton Systems Div.,** Woodland Hills, Calif., for digital computer and inertial guidance equipment spare parts and components.

$2,600,000—**Collins Radio Co.,** Dallas, for high-frequency, single-sideband communication transceivers.

$1,800,000—**Harvard Industries, Inc., Frequency Engineering Laboratories Div.,** Asbury Park, N. J., for production of electronic countermeasure (ECM) receivers.

$1,463,951—**Maxson Electronics Corp.,** Great River, N. Y., for production of ASW plotting boards.

$1,000,000—**Kollsman Instrument Corp.,** Elmhurst, N. Y., for altimeter production.

$205,900—**Republic Aviation Corp.,** Farmingdale, N. Y., for further development of the *Bikini* lightweight reconnaissance drone.

NASA

$189,000—**Martin Co., Electronic Systems and Products Div.,** Baltimore, for research in more dependable power systems for Earth satellites.

$83,600—**Electronic Communications, Inc., Research Div.,** St. Petersburg, Fla., for a 12-month study of techniques for superheterodyne receivers at frequencies about 100 gc.

$43,000—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for development of instrumentation for on-board measurement of pressure, density, temperature and winds during the boost phase of large space vehicles.

International Telephone and Telegraph Corp., Paramus, N. J., for provision of an automated data switching center at the Marshall Space Flight Center (undisclosed amount).

INDUSTRY

$5,500,000—**Mosler Safe Co.,** Hamilton, Ohio, from **Boeing Co.,** for provision of security devices for use at *Minuteman* launch sites.

$500,000—**Garrett Corp., AiResearch Div.,** Phoenix, Ariz., from **Boeing Co.,** for design, production and testing of *X-20 (Dyna-Soar)* pneumatic and cryogenic control valves.

$66,400—**Teleflex, Inc.,** North Wales, Pa., from the **University of California's Lawrence Radiation Laboratory,** for design and fabrication of nuclear control instruments used in Project *Pluto*.

Goodyear Aircraft Corp., Akron, Ohio, from **Westinghouse Air Arm Div.,** for development and production of radar radomes for *Gemini* rendezvous antennas (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Procurement and Production Office
Procurement Div.
Research and Development Branch
Laurence G. Hanscom Field
Bedford, Mass.

Design instrumentation to determine the thickness of a hypersonic boundary layer about an ICBM nose cone. To be negotiated with Block Engineering, Inc., Cambridge, Mass. Note: For information only. No RFP available. PR-CRL-1279.

Directorate Procurement and Production
Middletown Air Materiel Area
MAPDC
Olmsted Air Force Base, Pa.
Attn: Duane Gesell

Contract technical services for GAM-77 missile and AGE, bench maintenance, guidance systems, NTI and airborne operations for 312 man months by six technical representatives. Negotiations are being conducted with North American Aviation, Inc., Space and Information Systems Div., 12214 Lakewood Blvd., Downey, Calif. This is a continuation of Contract AF 36(600)-13682. Inquiries must refer to MA-4533-1-PDC. For information only. No RFP available.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Design, fabrication, installation and checkout of an electric arc discharge shock tube facility. The facility will consist of a megajoule capacitator bank, energy source circuitry, an arc discharge shock tube auxiliary vacuum and pressure equipment tanks and instrumentation. The energy source should be capable of establishing a potential of 40 KV across the driver chamber of the shock tube. The driver chamber should be designated for a peak pressure of 1000 ATM and have provision for establishing an arc along its

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And you'd be right...almost...but not quite. Because one such opportunity actually does exist.

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axial centerline and include a diaphragm section and a transition section to accommodate the pump tube. The transition should be tailored to minimize gas interface instabilities. Two pump tubes approximately 49′ long and approximately 9″ and 18″ in diameter are required to operate at nominal pressures of 1000 microns of Hg and 10 microns of Hg respectively. The installation should be capable of producing shock waves at speeds up to 50,000′ per second. Contract requires guaranteed performance, detailed design fabrication and installation at Moffett Field, Calif. The following firms have been invited to participate: Fluidyne, Minneapolis 22, Minn.; MHD Research, Inc., Newport Beach, Calif.; Attn: Mr. M. C. Reder; General Electric Co., San Francisco 6, Calif., Attn: Mr. Q. B. Swann; Thiokol Chemical Corp., Promotory, Utah, Attn: Mr. B. Petty; Marquardt Corp., Van Nuys, Calif. Job—RFP A-6636. RFP due date 4-29-63. It is suggested that small business firms and others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

Atlas Procurement Div.
SBAMA
Norton Air Force Base, Calif.

Order 04-607-63-2 against existing contract AFP 4(607)-7569 with Rocketdyne Div., North American Aviation, Inc., is in process. This procurement is for supplements, revisions and changes to technical manuals applicable to *MA-2* and *MA-3* propulsion system stage. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firm.

Southwest Div.
Bureau of Docks
San Diego, Calif.

Improvements to *Scout* launch complex consisting of construction of additions to existing buildings, earthwork, concrete work, blast doors, finish hardware, ventilation, air conditioning, plumbing, electrical, road and parking area work, related work Naval Missile Facility, Point Arguello, Lompoc, Calif. IFB No. 47446/62B. Bid opening 4-23-63.

Headquarters—U. S. Army, Alaska
Support Command and Fort Richardson
Director of Supply and Procurement Div.
APO 949
Seattle, Wash.

On-site operation and on-site maintenance services for the Army Alaskan *Nike* communication system. Operation of maintenance of interbattery communication at *Nike* sites. Delivery dates 7-1-63, 6-30-64. Deliver to U. S. Army Signal Officer, Fort Richardson, Alaska. IFB not furnished. Bid opening 4-16-63. Requests for copies of this proposal should be sent via air mail.

National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.
Phone: Code 713, WAlnut 8-2811, Ext. 7307

Design feasibility study for portable lunar survival shelter system, including materials, design, concept, support subsystems, equipment and provisions, packing and packaging, and ways and means for shelter erection. Specific qualitative and quantitative requirements shall be established for complete portable lunar survival shelter systems and for all their subsystems, provisions and equipment necessary to protect and support two lunar explorers for a specified length of survival time. Delivery to NASA, Manned Spacecraft Center, Houston 1, Tex. Job—RFP MSC-63-566P. RFP due date 4-30-63.

Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations to be conducted with Barnes Engineering Co., 30 Commerce Road, Stamford, Conn., for modification and installation of a cine spectrograph to enlarge the present study of radiation from missile boosters and sustainers. RFP—ASD-141296-RKMC. Note: For information only, no RFP available.

National Aeronautics and Space Administration
Wallops Station
Wallops Island, Va.

Four signal generators, one counter, two power meters, one attenuator, and one oscilloscope. RFP P-682. Bid opening 5-14-63.

National Aeronautics and Space Administration
Flight Research Center
P. O. Box 273
Edwards, Calif.

Automatic universal spectrometer—1 each. IFB PR 3436. PR due 4-29-63. Copies of IFB will be furnished to the extent available on a first-received-first-served basis. Contact Bid Officer L. D. Meyers. Phone: CLifford 8-2111, Ext. 46041.

Procurement and Production
Base Procurement Div.
L. G. Hanscom Field
Bedford, Mass.

Re-entry nose cones for the *Trailblazer II* vehicle with Cygmus 15 fourth stage motor—3 each. RFP PR CRL-0076. RFP due date 5-2-63.

Development of a preliminary design of an *Aerobee* sounding rocket of improved burnout attitude to be negotiated with the Space General Corp., El Monte, Calif. PR CRL-1394. Note: For information only. No RFP available.

Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

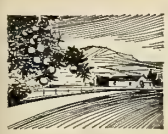
Design and fabricate a liquid-hydrogen vacuum-jacketed stainless steel piping system. Bid forms may be obtained by calling Huntsville, Ala., phone: 536-7497. IFB MSFC 63-294. Bid opening 4-30-63.

Lewis Research Center
2100 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with the Sperry Farragus Co. Div. of Sperry Rand Corp., Bristol, Tenn., for the procurement of one flight model ion engine programmer. RFP—FPR-3044. Note: For information only. No RFP available.

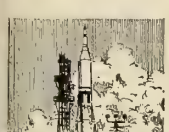
Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Tank, liquid oxygen. Deliver to George C. Marshall Space Flight Center—1 item. IFB MSGC-63-299. Bid opening 9-23-63.



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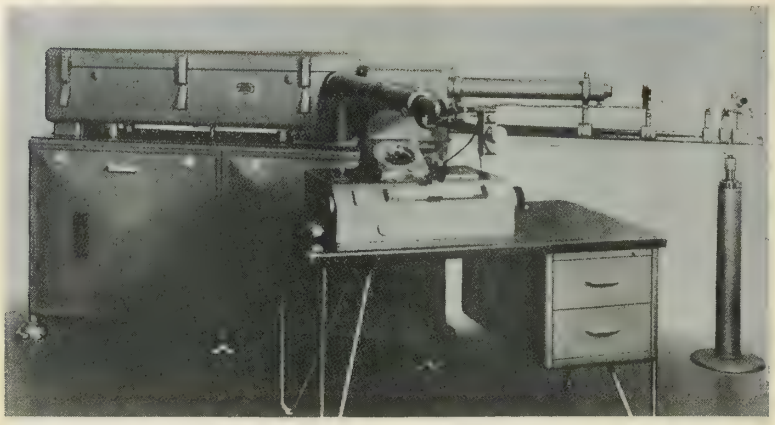
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Write: Professional Employment Office, Dept. 5204, P. O. Box 111, Redlands, California. An equal opportunity employer.

COMPANY

REDLANDS, CALIFORNIA

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New Product of the Week: Krypton-Source Meter Comparator

CARL ZEISS, INC., is marketing its newly developed meter comparator—an instrument capable of measuring gage block of any length up to 40 in. with an accuracy of 0.4 microinch. Metrology laboratories now can measure large gage blocks on their own premises with an accuracy attainable only by optical means, Zeiss says.

Measurements are made in light wavelengths of the krypton-86 orange-red line, established in 1960 as the universal standard for defining the meter.

The unit consists essentially of a krypton-lamp light source; a collimator; a triple-prism monochromator that separates from the parallel beam the desired spectral line to be used for measuring; a Koesters prism, separating this light into two coherent beams; a measuring trough, in which the gage block to be measured is placed; and a telescope objective of 1200-mm. focal length, through which interference fringes are viewed.

A cadmium lamp may be employed in place of the krypton isotope lamp, providing a greater distance between the useful spectral lines.

A series of devices are said to enable the operator to control and measure environmental factors in the trough with extreme precision. The refractive index of air is determined by means of a built-in vacuum chamber system. Measurements are made simultaneously in parallel air-filled and vacuum chambers, and the fractional difference is viewed through the instrument's eyepiece.

Circle No. 225 on Subscriber Service Card

Cross-Connect Matrix

A high-density matrix that provides random-access interconnection—and is suited to missile checkout and data-logging equipment—has been developed by Sylvania Electric Products, Inc.

Consisting of a laminated sandwich of circuits, the unit provides pair connections between any input or output by inserting a single connector pin. The unit available in pair combinations of 25x25, 50x50, 75x75 and 100x100.

Circle No. 226 on Subscriber Service Card

Position Servo Package

Diehl Manufacturing Co. is marketing a standard, 60-cycle position servo package. The system accepts a-c or d-c voltage or synchro input and produces a shaft-position output.

The package contains feedback sensor, servo amplifier, servo motor-tachometer, gear train and compensation circuitry. The motor has a stall torque of 1.7 oz. in. and a no-lead speed of 3400 rpm. Gear ratios to 2000:1 are available with a slip clutch.

Accuracy of the system is one part in 10,000; frequency responses is five cycles/sec; velocity constant is 30 sec^{-1}. These are nominal values, varying with the load, the sensor and the gear ratio.

Circle No. 227 on Subscriber Service Card

Bidirectional Counter

A high-speed, bidirectional counter using a different type of counting circuit has been developed by the Perkin-Elmer Corp.

The Series 100 is completely transistorized and will count in any of three modes—straight binary, binary coded decimal, or in degrees/min. It counts bidirectionally at input pulse rates from zero to more than 100kc.

The counter will accept: two-phase overlapping pulses, the usual type of signal developed by an optical incremental shaft encoder; three-phase pulses, overlapping on non-overlapping, used in differential counting and with various other types of input devices; single pulse, unidirectional counting only.

Circle No. 228 on Subscriber Service Card

Simulator

Marketed by Telemetrics, Inc., the all-solid-state Model 301 produces PAM/RZ and PAM/NRZ serial pulse trains with subcommutation of up to eight channels, simulating the output of FM or PAM receivers, mechanical or electronic commutators, sub-carrier discriminators or tape recorders.

Commutation rate is continuously variable from 10 to 60K pulses per sec. Frame length also is continuously variable, from 1 to 2,048 channels. Duty cycle of the RZ signal can be varied from 45% to 65%; the NRZ signal has 100% duty cycle.

A subcommutated channel can be substituted, with any percentage of full-scale amplitude, at up to eight different locations in the pulse train.

Circle No. 229 on Subscriber Service Card

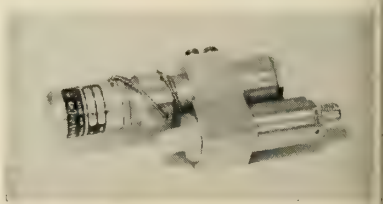
Amplifier Group

Virginia Electronics Co., Inc., is marketing Model #240 transistorized plug-in P.C. amplifiers, which are stacked for a maximum of 100 cards per power supply. Gains are adjustable to 20 db with one milliwatt output, 300 to 3000 cycle response. Designed to compensate for cable losses, the unit meets military requirements.

Circle No. 230 on Subscriber Service Card

Pressure Reducer

A standard reducer available from Pneu-Hydro Valve Corp. regulates a constant or decaying inlet pressure of 5,000 psi to a set pressure, adjustable



over a range of 100 to 2,000 psi at outlet. The device was developed as a control component for pneumatically pressurized systems in space. The unit has a built-in device for arresting the explosive shock caused by initiation of pressurization.

Circle No. 231 on Subscriber Service Card

Piezoelectric Accelerometer

Statham Instruments, Inc., is marketing eight piezoelectric accelerometers for measurement of shock and vibration. The series employs a sensitive "self-energizing" piezoelectric element for reliable measurement in a variety of missile/space applications.

Features of the units are: Model AK116 self capacity of 8000 picofarads allows output to be fed directly into a vacuum tube voltmeter; Model AK119—sensitivity of 60 peak mv per peak g; Model AK120—light of 0.3 oz.; Model AK117—natural frequency of 100 KC; Model AK118—wide temperature range of −320° to 500°F; Model AK121—tri-axial instrument employing three elements orthogonally mounted; Model AK115—application as a general-purpose instrument; and Model AK122—hermetically sealed, general-purpose instrument.

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Thermistor

Ruggedized thermistor probes—consisting of miniature thermistor beads hermetically sealed in shock-resistant glass—have been developed by Fenwal Electronics, Inc. The probes are used for temperature sensing, temperature compensation of electronic circuits and miniature gyroscopes.

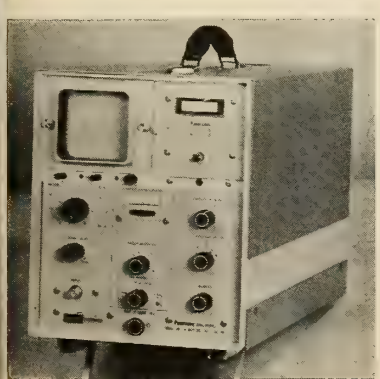
The units are designed to withstand high shock and vibration loads, and are available with resistance values from 100 ohms to 10 megohms. Typical dissipation constant is one milliwatt/°C.

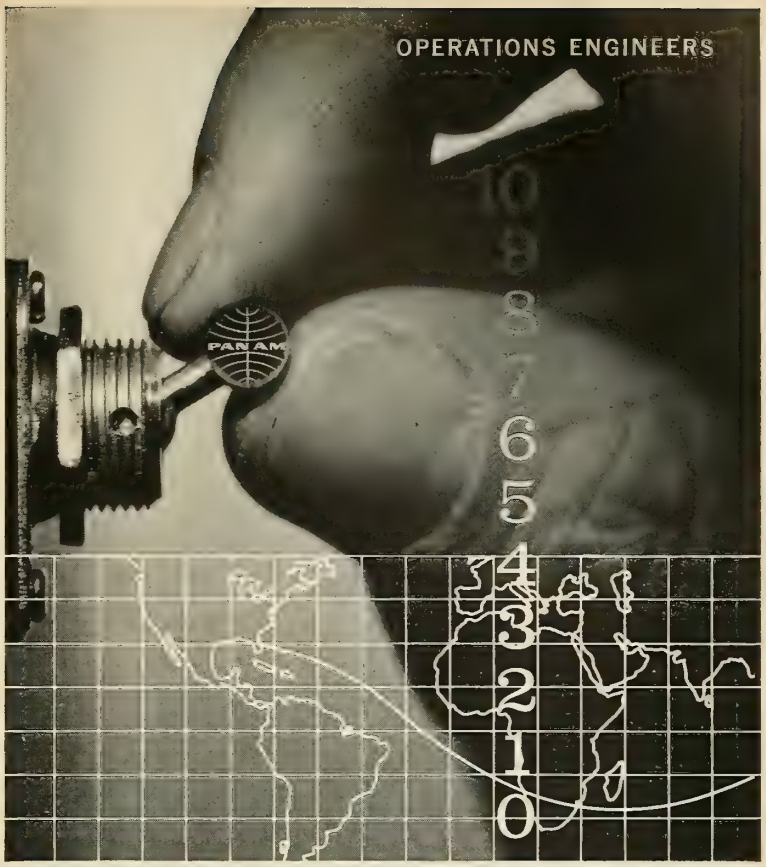
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Portable Spectrum Analyzer

A completely transistorized portable spectrum analyzer is available from the Singer Metrics Div., Singer Mfg. Co.

The instrument, with AR-1 plug-in module, provides high sensitivity with 30 microvolts full linear scale and 250 microvolts full log scale. It also offers direct-reading db and standard-voltage CRT scales. The unit's batteries automatically recharge during a-c operation. A 20-kc scan bandwidth in one second





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For further information, write in confidence to Dr. Charles Carroll, Dept. 56D-3

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permits surveillance of the entire sonic spectrum at a glance. Detailed narrow-range analyses are made by linear scan segments that may be 200 to 500 cps wide, centerable anywhere in 0-20 kc.

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PCM Telemetering System

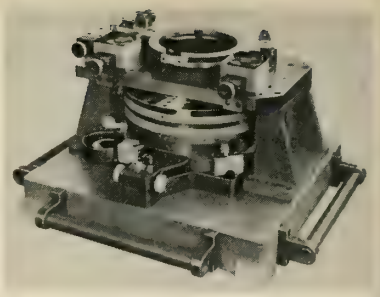
Arnoux Corp. has developed a PCM telemetering decommutation system accepting single-ended input signals that are either plus or minus with respect to ground. Automatic gain control is provided for each of three input-signal voltage ranges: 0.5-5v, 1-10v and 5-50v. Bit synchronization is accomplished thru a digital type phase-lock with automatic frequency correction. Three window widths—25%, 41% and 57% of bit period—are automatically selected, depending on the discrepancy between incoming bit rate and local oscillator frequency.

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Ultra-Ro-Dex

Developed by AA Industries, Inc., the Ultra-Ro-Dex combines a rotary table having a runout accuracy of 20-millionths of an inch, with an indexing table that will index to any of 360 degrees with an accuracy of less than ¼ sec. of arc for any degree.

The rotary table is fixed in a plane



parallel to the base and is free to rotate until the lower portion of the indexing table is moved upward into engagement. There are 360 precision-ground serrations, in both the upper and lower portions of the indexing unit, that provide instantaneous indexing to any full degree.

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Composite Environment Unit

Del-Vac Engineering Co. has available its Model ALICE (Absolute Lowest Indicating Composite Environment) diffision-pumped, double-jacketed vacuum system for routine work-horse operations in the 10^{-10}-torr and lower vacuum regions.

Applications include engineering determinations in the space sciences, controlled-atmosphere metallurgy; and advanced development and precise production operations in solid-state transistor and computer devices.

Circle No. 237 on Subscriber Service Card

Double Emitter Choppers

Texas Instruments has developed a line of six different double-emitter chopper transistors, 3N74 through 3N79. The units are designed to replace matched pairs, providing uniform performance and reducing external circuitry,TI says.

Features of the chopper are said to include high breakdown voltage, low emitter currents—to two na at ±15v—and standard lead pattern (emitter-base-emitter-case).

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Swiss Micrometer

Developed by Tesa, the Tesamaster micrometer eliminates errors in reading, making precision measuring faster and easier.

One of the features is the Tesamaster parallax design that allows the thimble and vernier graduations to be on a level with one another giving readings to 0.0001 in. or better.

The unit's direct-window reading allows reading to 0.005 and eliminates mental arithmetic and consequent errors; and its design offers oblique graduations for the 0.100-in. lines.

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An efficient "white room" ultrasonic cleaning system is not just a piece of equipment that does its job more often than not. It must encompass three primary considerations: 1. The components to be cleaned. 2. The chemical or solvent essential to the cleaning. 3. Equipment appropriate to the components and cleaning solution and compatible with the environment. The right combination provides HIGH RELIABILITY.

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new literature

CRYOGENIC VALVE—A four-page technical bulletin describing high-pressure, cryogenic and high-temperature pneumatic-solenoid valves is available from Calmec Mfg. Corp. Included is a flow-capacity reference chart for quickly determining pressure loss, actual flow rate and required port area for valves used with helium and nitrogen.

Series 400 valves are produced in ¼- through 1½-in. tube sizes with 5250-psi rated proof pressure and high flow capacity. Stainless steel or aluminum bodies are available for operation over three temperature ranges: −420° to 200°F; −65° to 200°F; and −65° to 600°F.

Circle No. 200 on Subscriber Service Card

PERT COST FILM—Management Systems Corp. offers a 16-mm color film illustrating PERT COST system theory and operation. The 27-minute motion picture is designed to introduce PERT COST system concepts to all levels of project management and staff groups. It explains in detail the planning and control framework used in PERT COST to generate integrated time and cost status information for project management evaluation.

Circle No. 201 on Subscriber Service Card

ENGINEERING ANALYSIS FORM—A simple form available from Hygrodynamics, Inc., helps to pin-point instrument requirements from simple humidistats to measurement, control and recording, or the more complex central data-collecting systems for humidity. The form provides the assistance of experts in the field of hygrometry to recommend the simplest instrumentation for problems of moisture and temperature determination and control, humidifying, dehumidfying and quality control.

Circle No. 202 on Subscriber Service Card

CONTROL MODULES—A concept in modular electronic circuits for control applications is described in "Handbook of Output Driver Applications," offered by Sectron, Inc. The 24-page booklet covers design, functions and use of output drivers and describes the application of these electronic modules to control systems.

Circle No. 203 on Subscriber Service Card

DIGITAL VOLTMETER—A data sheet (190115) describes a specially-developed digital voltmeter manufactured by Cohu Electronics, Inc., Kin Tel Division, for submarine and other special environment applications. The Kin Tel 502BZ, an a-c/d-c DVM, has its circuit automatically and continually calibrated against a Zener diode reference source.

Circle No. 204 on Subscriber Service Card

Is There Really A Substitute For Experience In Command Equipment?

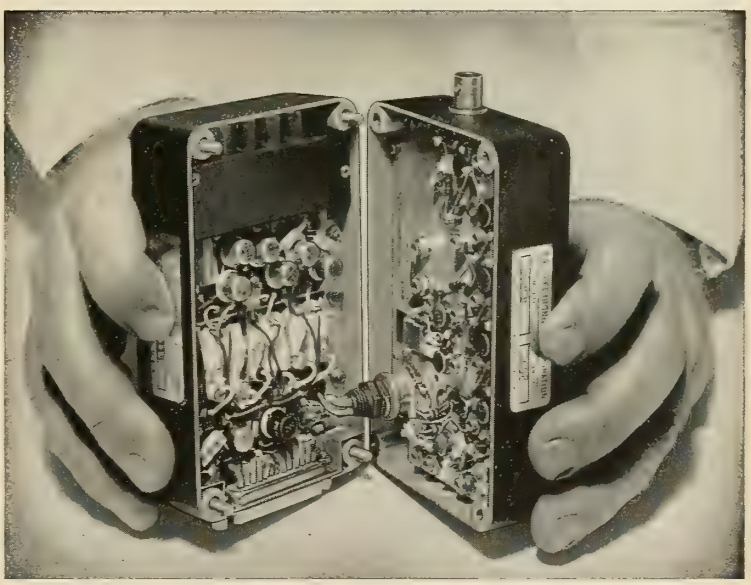
Not that we know of—RS Electronics command equipment has been successfully flown in thousands of flights, in both missiles and drones. These flights demonstrate that, with high reliability RSE equipment, you command with confidence.

RSE's complete line of command equipment includes tube and transistorized UHF FM command receivers, command decoders, telemetry and guidance transponders, and transmitters. Whether your needs are for command control, guidance, or command-destruct, on board missiles, target drones, or satellites, RSE has a unit for you.

RSE design gives you maximum flexibility with standard receivers mating with standard 2, 3, 5, 6 and 10 channel decoders. All equipment is pretested, qualified, and ready to plug in and use.

Whatever your command application may be, up to the highest military standards, we welcome the opportunity to examine your requirements. If we don't have a standard unit suited for your purposes, we'll gladly produce one.

SPECIFICATIONS (Typical Receiver/Decoder) **Frequency** 406-549 Mc / **Sensitivity** Five microvolts / **RFI** Meets MIL-I-26600 / **Environment** MIL-E-5422 E Class 1 / **Size and Weight** 43 cu. in., 35 oz. / **Outputs** Six independent commands.



PERFECT MATES: RSE command receivers and decoders are designed to mate with each other, regardless of the number of channels, to provide maximum utility. In all cases the result is a small, lightweight package capable of meeting military airborne environments.

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3

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names in the news

Vernon R. Rawlings: Vice president of the Martin Co.'s Middle River, Md., facility, honored by the Air Force for his "outstanding contribution to the deterrent strength and security of the United States and Free World by insuring timely activation of the *Titan I* and *Titan II* weapon systems."

Robert J. Murphy: Vice president of the Boeing Co., named manager of its Washington, D. C., office.

David J. Havard: Appointed assistant manager in Hughes Aircraft Co.'s international liaison activity in Washington, D. C.

Dr. William Shepherd: Joined Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp., Mountain View, Calif., as a member of the technical staff in research and development.

Arthur R. Gold: Appointed a member of the senior technical staff of Advanced Communications, Inc., Chatsworth, Calif.

Roger Lee: Appointed administrative director of Telecomputing Corp.'s Electronics Systems and Data Instruments Divisions, North Hollywood, Calif.

H. Wayne Hix: Appointed manager of installation, maintenance and operations in the Government Products Div. of Adler Electronics, Inc., New Rochelle, N. Y.

Dr. Darol K. Froman: Joined the scientific directorate of Douglas Aircraft Co., Santa Monica, Calif.

Wade H. Boggs: Appointed technical sales representative for the Southeastern States Sales and Service Office of Cadillac Gage Co., Huntsville, Ala.

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Charles P. Baswell: Named president of Motorola, Inc.'s Overseas Corp., Chicago.

Max Lehrer: Appointed controller, Defense Electronic Products, Radio Corp. of America, Camden, N. J.

Timothy N. da Silva: Appointed senior engineer in the Product Reliability Department of Signetics Corp., Sunnyvale, Calif.

Dr. Bernard Friedland: Named principal staff scientist in control at General Precision's Aerospace Research Center, Little Falls, N. J. **John J. Brett** appointed manager of the STAFF program and **John C. Stiles** named engineering manager of the *MMRBM* engineering department.

Brig. Gen. Richard M. Hurst (USA ret.): Joined Textron's Bell Aerosystems Co., Buffalo, N. Y., as vice president for planning.

Clyde R. Rockwood: Named operations manager of Raytheon Co.'s semiconductor facility at Mountain View, Calif.

Philip J. Bettendorf: Appointed market manager—industrial products at the Roots-Connersville Div. of Dresser Industries, Inc., Connersville, Ind.

Irwin Rudich: Promoted to the position of chairman, management committee, Semiconductor and Receiving Tube Div. of Amperex Electronics Corp., Hicksville, L. I., N. Y. **John Messerschmitt** promoted to chairman, management committee, Tube Div.

Louis M. Peril: Named international marketing coordinator for Laboratory for Electronics, Inc., Boston.

Dr. Donald W. Gade: Elected senior vice president of California Computer Products, Inc., Anaheim, Calif.

Dr. James H. Brown: Appointed manager of the support operations section of General Electric Co.'s Space Sciences Laboratory, Valley Forge, Pa.

Dr. Joseph S. Smith: Appointed assistant manager of Sperry Gyroscope Co.'s Air Armament Div., Great Neck, N. Y.

Col. Robert J. Lynch (USAF ret.): Appointed director of command-and-control systems at General Precision, Inc., Tarrytown, N. Y.

Eugene Perchonok: Appointed associate director, Propulsive Vehicle Systems, in Aerospace Corp.'s Systems Research and Planning Div., Los Angeles. **Charles H. Kelley** named program manager of the Survival Improvement Office.

George R. Donovan: Appointed assistant manager of Thiokol Chemical Corp.'s central district office, Dayton, Ohio.

Michael P. Arndt: Appointed director of the Financial Control Dept. of TRW Electronics, El Segundo, Calif. **Daniel A. McMillan** named director of market and product planning.

John W. Dixon: Named director of plans for Ling-Temco-Vought, Inc., Dallas.

Robert W. Beckwith: Appointed manager, information systems, for Gulton Industries, Inc., Metuchen, N. J.

Frank E. Davis: Named director of the Space Div. at Aero Geo Astro Corp., College Park, Md.

R. William Caldwell, Howard N. Fenn and Dr. Melvin J. Hunter: Elected vice presidents of Dow Corning Corp., Midland, Mich. **Burl D. Huber** elected treasurer.

—when and where—

APRIL

International Symposium on Optical Masers, sponsored by Polytechnic Institute of Brooklyn, IRE, Optical Society of America, AIEE and U. S. Defense Research Agencies, New York City, April 16-18.

AIEE and IRE International Nonlinear Magnetics Meeting, Shoreham Hotel, Washington, D. C., April 17-19.

Institute of Environmental Sciences, Technical Meeting and Equipment Exposition, Statler-Hilton Hotel, Los Angeles, April 17-19.

Institute of Radio Engineers, Southwestern Conference and Electronics Show, Dallas, April 17-19.

American Astronomical Society Meeting, University of Arizona, Tucson, Ariz., April 17-20.

AIEE Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, Ohio, April 22-23.

AIAA Second Manned Space Flight Meeting, co-sponsored by NASA, Marriott Motor Hotel, Dallas, April 22-24.

American Physical Society Meeting, Washington, D. C., April 22-25.

Hypersonic Ramjet Conference, sponsored by ASME, ARS, and U. S. Naval Ordnance Laboratory, White Oak, Md., April 23-25.

National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla., April 23-25.

AIEE Power Industry Computer Application Meeting, Westward Ho Hotel, Phoenix, Ariz., April 23-25.

AIEE Southeast District Meeting, John Marshall Hotel, Richmond, Va., April 24-26.

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Management or Mediocrity?

ONE OF THE BIGGEST problems today in the relationship between industry and the Dept. of Defense lies in the area of program management. Under the Pentagon reorganization of Secretary McNamara, increasing attention is being paid to the organization philosophies and procedures for management of large-scale programs.

The Defense Dept. is engaged in what it refers to as "monitoring" of some 125 weapon system programs. The problem arises from the question of where to draw the line in this monitoring—where should DOD program management cease and industry management begin?

Finding the correct answer to this question is vital because the quality, cost and delivery schedules of the nation's future weapon systems depend to a great extent on the success of the military-industry management relationship.

Yet there has been little indication to date that the Dept. of Defense really understands, or trusts, industry competence in management of its weapon projects. There is entirely too much suspicion that industry is trying to hoodwink its military customers out of every possible penny. Industry, on the other hand, has been much too impatient with Dept. of Defense efforts to monitor the money DOD is spending. The attitude of too many companies has been, in effect, "Give us the money and leave us alone. We'll deliver the goods to you when ready."

Such a course would be an abdication of DOD's responsibility to the taxpayer. There is a middle ground where the opposing points of view can meet, but there has been little successful effort to date in finding it.

One such effort was made last week in a program management seminar at the Society of Automotive Engineers national meeting in Washington. A day-long forum was devoted to program management, with government spokesmen putting forth their views in the morning session while industry program managers got a chance to sound off in the afternoon.

Dept. of Defense spokesmen were emphatic in their insistence that the new Pentagon philosophy demands appropriate cost control on contracts. There was little quarrel with this by industry speakers—but considerable disagreement on just how and where this control should be applied.

It was evident that a major problem arises from the fact that philosophy in cost control is running several years behind contracting philosophy. Only now is the Defense Dept. beginning to institute the type of cost control which should have been in effect much earlier. This control is aimed at cost-plus-fixed-fee contracting, where the military has much the greater interest in holding down cost.

But the Dept. of Defense meanwhile has moved on to increased emphasis on fixed price-plus-incentive fee or fixed-fee contracting. A contractor with a fixed-price contract must impose rigid cost control or he can suffer a severe financial loss. On extremely large-scale contracts, it could be sufficient to put the contractor out of business.

Yet the Pentagon is attempting to impose its new cost-control philosophy designed for CPFF contracts on the increasingly larger number of fixed-price contracts. This is wrong, and it is at the heart of much of the trouble.

The fixed-price contract, with or without incentive clauses, imposes on the contractor the necessity of providing the severest cost controls. This is, in fact, an additional service which DOD is obtaining under this form of contracting. Yet any attempt by DOD to meddle in those same cost controls must invariably breach the contractor's right to protect himself. When the responsibility rests with the contractor for cost control, the authority must rest there also.

The military services and DOD itself must be prepared to trust the experience of contractors in this field rather than imposing a supra-control level devoted slavishly to rigid management philosophies such as PERT.

PERT-time and PERT-cost systems have many advantages. But they also have disadvantages and cannot be applied without consideration for the knowledge and experience of the firms involved. On one multimillion-dollar fixed-price contract, the PERT system recently indicated that a critical subsystem would not be ready on schedule. Obviously, this called for a complete revision of the entire program schedule. But the company decided to gamble on its past experience with the subcontractor and to go ahead with the program on the original schedule. As hoped, the subsystem came through on time.

Only experienced industry management can make such a decision—and on a fixed-price contract the decision is made in full knowledge of the risk involved. Any attempt by less experienced military program management to adhere strictly to PERT would have resulted in program delay and higher cost.

Under the fixed-priced concept, the military must develop the in-house competence to be certain the fixed price negotiated with a firm is a fair one for the taxpayer. DOD must have the know-how to drive the hardest possible bargain without crippling the program by awarding it to a bidder lacking the competence or financial resources to complete the job. But once the contract is signed, the Pentagon must have the confidence in industry management to let it carry the job of cost control from there.

THE GROWTH of fixed-price contracting in large-scale defense spending is welcome. But it must be accompanied by complete Dept. of Defense acceptance of the fact that industry has management personnel with the competence and experience to do the job.

The Pentagon must abandon what one SAE speaker called the "DDR&E management syndrome" and acknowledge that DOD cannot ever begin to match the resources of industry in management personnel.

William J. Coughlin

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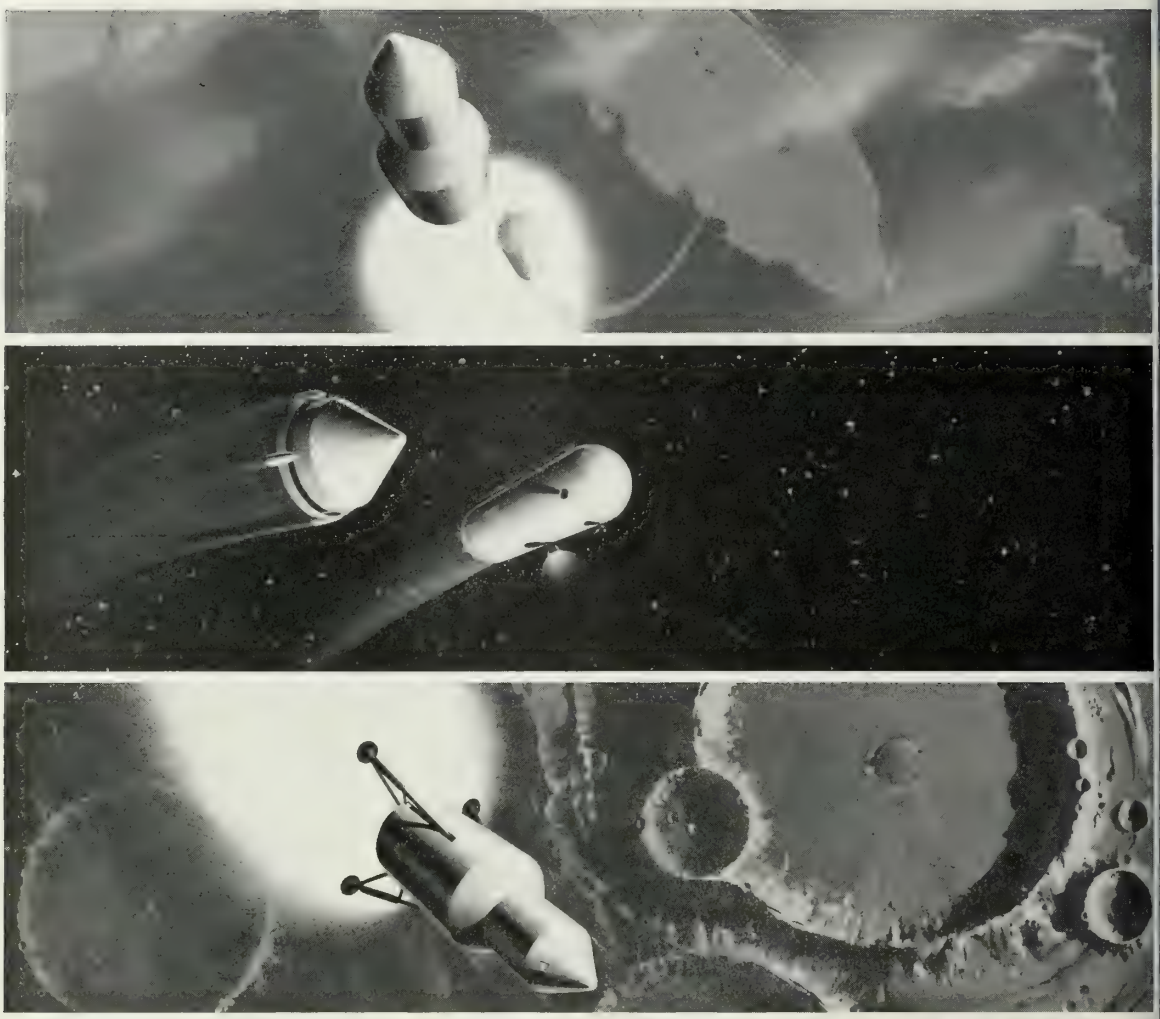
Responsibilities: Determine functional design requirements for advanced air-launched missiles; the design of such systems to meet customer requirements and theoretical analysis of system performance; coordinate and assist engineering departments in the development of equipment to fulfill the system requirements.

Experience: Two years minimum in one or more of the following fields: **1.** System engineering on missile or fire control systems. **2.** Field engineering on airborne fire control systems or missile systems. **3.** Test and evaluation of comparable systems. **4.** Radar systems (pulse doppler). **5.** Target tracking systems. **6.** Autopilot and control systems. **7.** Microwave systems. **8.** Digital computers. **9.** Navigation systems. **10.** Inertial components. **11.** Electrical power and armament control subsystems. **12.** Circuit design and electronic packaging.

Education: B.S. in E.E., M.E. or Physics. Articulate in communications. U.S. citizenship required.







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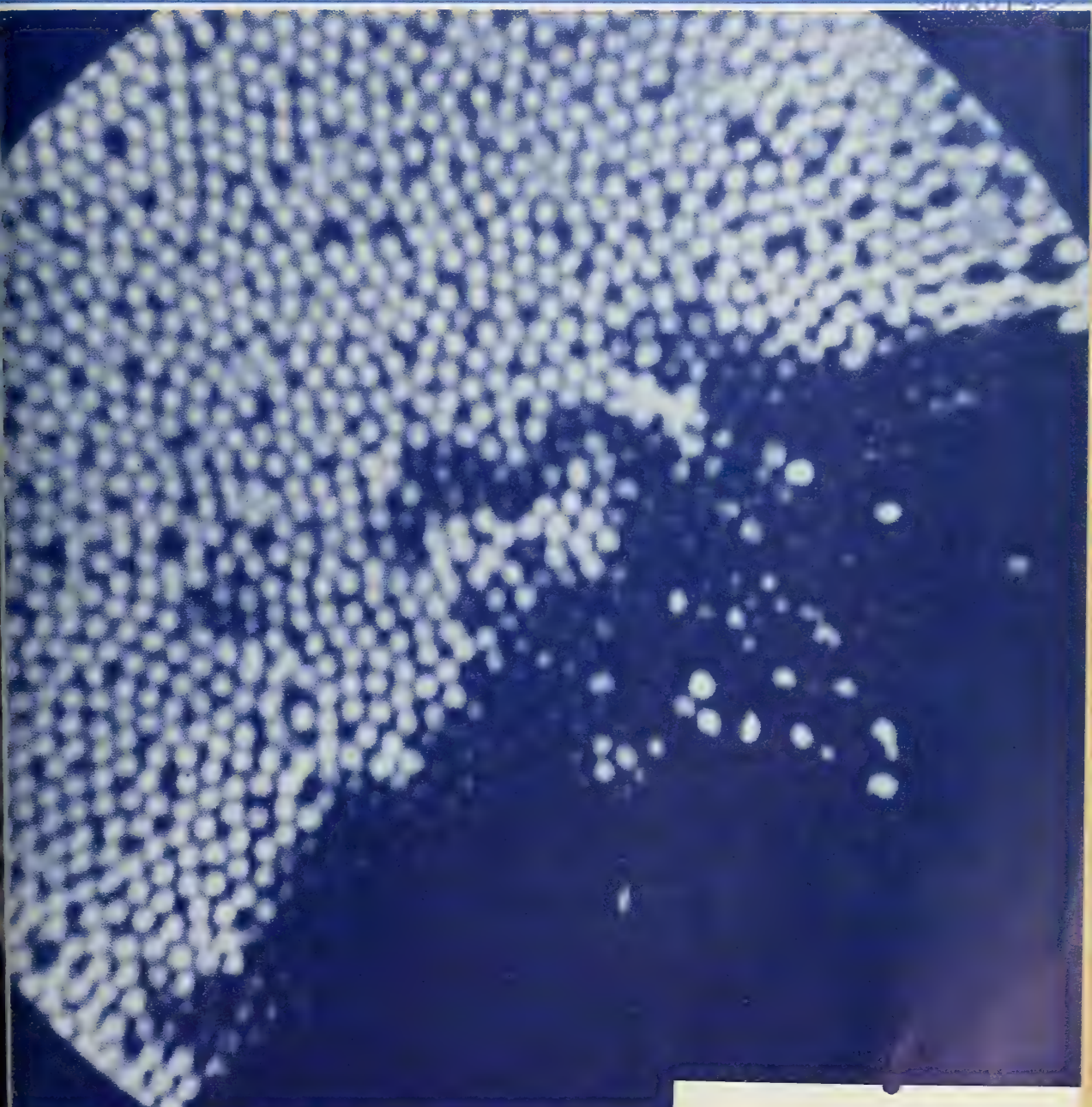
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APRIL 22, 1963

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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Contact: Mr. H. D. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California

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missiles and rockets

Volume 12, Number 16 April 22, 1963

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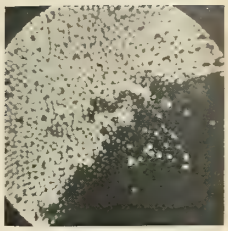
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THE COVER

Ion image taken with Electro-Optical Systems ion microscope of tungsten wire bundle ionizer. Dark area corresponds to low-ion emission, next area is ion emission from pores, and third section is ion emission from wire ends. *See p. 28.*

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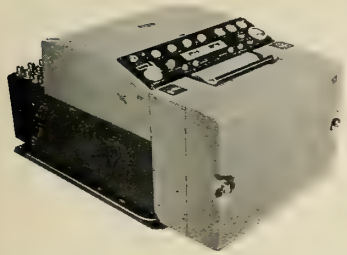
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letters

Military Systems Issue

To the Editor:

I have read the March 25 Special Military Systems Issue of M/R and am impressed with the extensive research which was conducted. You have succeeded in presenting a very complicated subject in a clear, comprehensive manner.

While not agreeing with all the views expressed, I do agree that you have performed a useful service to your readers by presenting a detailed description of the organization and operation of the Department of Defense.

Cyrus R. Vance
Secretary of the Army
Washington, D.C.

Block That Metaphor

To the Editor:

Your April 8 editorial continues with the same harangue over the imminent cancellation of the *Dyna-Soar (X-20)* program.

Certainly by this time you are aware that the *X-20* program cannot provide for current military or scientific goals. Let's face it—*Dyna-Soar* is obsolete.

So, why don't you climb down from your pedestal, and quit dragging this dead horse through the mud!

Paul E. Martin
Senior Research Engineer
Mountain View, Calif.

No Lunar Orbit

To the Editor:

In your April 8 issue was an article entitled "Lunik Boosts NASA Funding Hopes." In it was stated that "The Soviets have launched three previous Moon probes. The first, which went into orbit around the Moon. . . ." I believe there is a small error here. The first Russian Moon probe *(Lunik I)* did not orbit the Moon. It passed close to the Moon and then went into orbit around the Sun, becoming an artificial planet of our solar system. Since a true Moon orbit has never been achieved by either the Soviet Union or the United States, I feel that this should be corrected.

James Reynolds
Elmore, Ohio

Reader Reynolds is correct—the first Lunik went into solar orbit.—Ed.

Appeal to the President

To the Editor:

Your editorial "An Appeal to the President" (M/R, March 18) was in our opinion an excellent example of free speech not often practiced in our press today. Seldom does one see such an honest, forthright, courageous appeal in the press. We admire your integrity and commend your publishers for speaking the truth loud and clear.

Your appeal, so clear and articulate, in quoting and questioning, can only make thinking men think.

As citizens protesting the ever-enlarging policy of our leaders to give magnificent promises followed by vacillating compromise and inaction, we thank you. Please keep up this kind of editorial—you give others strength.

R. T. Kendall
Palos Verdes Estates, Calif.

Surface Signatures

To the Editor:

Your article (M/R, April 8, p. 22) on the surface signature program at Texas Instruments was read with great interest here at the Antenna Laboratory of The Ohio State University. The idea of identifying terrain by its radar properties is a rather old one, as radar technology goes, but lack of basic knowledge about the scattering behavior of terrain has, until recently, limited its usefulness.

The Department of Electrical Engineering at The Ohio State University has been concerned with this problem of identifying terrestrial and lunar surfaces by radar for nearly 10 years, and we were naturally quite pleased to see that some of our data had been used to support the proposals made in the article. However, in fairness to my colleagues, I believe your readers should know that the data referred to in the figure at the bottom of page 23 of your article was not the work of Texas Instruments at all, but was presented by Mr. R. C. Taylor of the Antenna Laboratory at the 1959 IRE National Convention (Conv. Record Vol. VII, part 1, page 19).

William H. Peake
Associate Supervisor
Antenna Laboratory
Department of Electrical Engineering
The Ohio State University
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Guide to Alphabetese

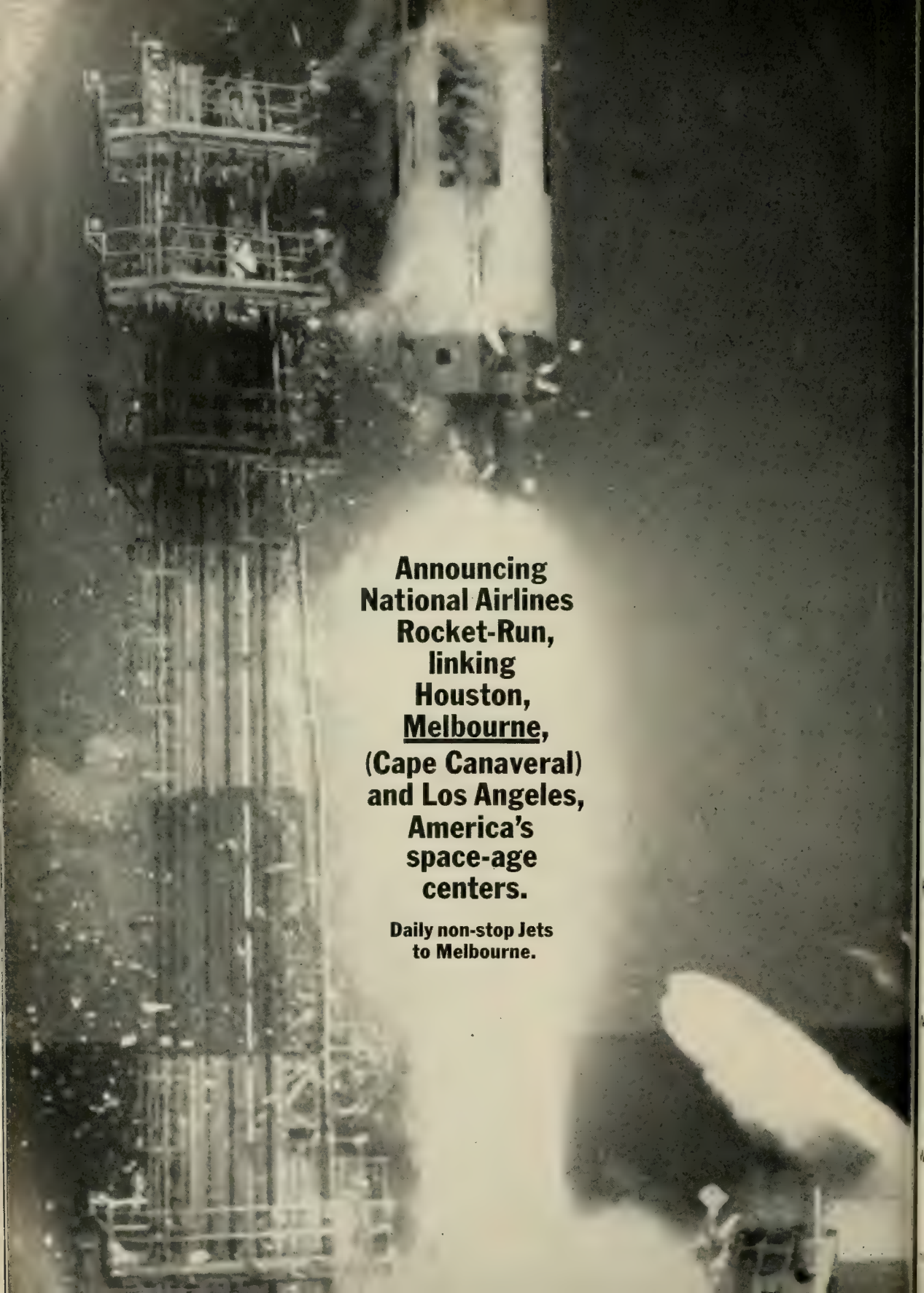
To the Editor:

We are readers of MISSILES AND ROCKETS and have difficulties in finding the sense of all abbreviations.

If you can help, please let us know.

Herr Reiner
Bundesverband der Luftfahrtzubehör und Raketenindustrie e.V.
Hamburg, W. Germany

This is one of numerous letters we have received requesting similar guidance. American Aviation Publications printed a guide to missile/space abbreviations a few years ago, but we haven't gotten around to updating it. However, Raytheon Co. has filled the gap with its publication "ABRACADABRA" (ABbreviations & Related ACronyms Associated with Defense, Astronautics, Business and RAdio Electronics). Write to Office of Public Relations, Raytheon Co., Lexington, Mass., and ask for Form 0289.—Ed.


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The Countdown

WASHINGTON

NASA Calls for Space Station Bids

The Manned Spacecraft Center in Houston has asked for bids by May 10 for a preliminary design and engineering analysis of a large manned orbiting space station. Each bidder will consider a three-radial module configuration but also will study an alternate concept. The station would provide space for 18 men and up to 36 in an emergency. Radius would be 150 ft. Lifetime: one year at a 200-to-300-mi. orbit.

Redeye and Mauler Value Questioned

A top Defense Dept. official says there is a serious question as to whether *Mauler* and *Redeye* represent the optimum weapons for knocking down aircraft. He notes that *Redeye* when conceived was visualized as a rather simple weapon—essentially a rocket with a *Sidewinder* nose, both miniaturized. But he says *Redeye*, although expected to perform the *Sidewinder* mission at one-tenth the weight, is every bit as sophisticated a system as *Sidewinder*. "Perhaps we should be considering another way to do this mission," he adds. The official: Dr. John McLucas, deputy director, Defense Research & Engineering. Complexity of *Mauler* also is being studied.

Test Set for Swiveled Solid Attitude Motors

First of two rockets testing swiveled solid-propellant attitude control motors is to be launched by NASA from Wallops Island in October. The attitude control system, called VECTOR, is conceived primarily as an off-the-shelf system for low-cost, short-leadtime rocket probes. Some NASA engineers find the principle interesting for the proposed solid *Nova*. Allison Division of General Motors makes the 60-lb.-thrust motors for VECTOR. Control system is by Space General Corp.

Nuclear Rocket Program Slippage Confirmed

Slippage in the U.S. nuclear rocket program has become publicly apparent. Project chief Harold B. Finger told Congress recently that he hopes the first RIFT flight will be made before the end of the decade. But he declined to specify a date. The original schedule calling for a 1966-67 launch now is regarded as far too optimistic.

How to Do Business While Really Trying

NASA procurement officials, with the support of the Small Business Administration, are touring the country to acquaint industry with how to do business with the space agency. Savannah, Ga., will be visited on May 10 and a June visit to New York is planned. Meetings will be held in several other cities before year's end.

MA-9 Date Set for May 7

Earliest date for Project *Mercury's MA-9* flight now is set at May 7. Previously, NASA had said mid-May in anticipation of slippage in flight plans. AT&T's *Telstar* communications satellite—originally set for a May 7 launch—has been moved up one day. Both will go from Cape Canaveral.

Which Is Hunter and Which Is Hunted?

Secretary of Defense McNamara made no move to correct a statement on *Nike-Zeus* by Sen. John Stennis (D-Miss.) when the Senator declared that the mid-December intercept by *Zeus* was a setup where "the target more or less sought the weapon" and that subsequent Army announcements were misleading. McNamara told Stennis during testimony that there has been a "strong temptation for the Army to overstate the success of the *Zeus* and the Air Force to deny it has been successful." He said all future releases on intercepts will be cleared not only by both services but by his office.

Polaris 'More Dependable' than Minuteman

Defense Secretary McNamara says *Polaris* missiles are "far more dependable" than *Minuteman*. The comment came during testimony in which McNamara noted that many U.S. missile systems now are as reliable as some aircraft systems. "I recall very vividly being at Omaha a few months ago on a day when almost literally all of our B-58 bombers were unavailable for alert status because of mechanical failures," he declared.

Shrike Anti-Radiation Missile Given Boost

Dept. of Defense official John H. McLucas says the new *Shrike* anti-radiation missile designed for launch by Navy and Air Force aircraft against enemy radar is a missile "worth deploying." He says the missile has the capacity to seek and kill radars operating in the X and Y bands and the newer C band. "We also should be able to track CW radar, chirp radar, frequency agility systems, and others," he says.

INDUSTRY

BSD Interested in Five-Engined Atlas

Ballistic Systems Division is giving serious consideration to the proposal by General Dynamics/Astronautics for a five-engined *Atlas* Mark 2 to be used as booster for a 100-megaton warhead. The missile, similar to early *Atlas* proposals but larger, would have a half-stage of four booster engines surrounding a single sustainer engine. A single tankage system would supply conventional liquid oxygen and RP-1 propellants for all engines. Proposal also was made to Space Systems Division for space vehicle work but has drawn only academic interest.

Westinghouse Gets New NERVA Role

A switch in the nuclear program has given Westinghouse Electric full responsibility for designing and building a reactor for the NERVA nuclear engine. The firm, along with Aerojet-General, NERVA prime contractor, also has been told to study alternate designs rather than sticking strictly to the general Kiwi B4 reactor design. Work will be parallel to, but not governed by, that of AEC's Los Alamos Laboratory, which did the original design work on the reactor.

INTERNATIONAL

Australian Target Missiles Tested at PMR

A second series of evaluation flights on *Jindivik*, Australian target drone, is under way on the Pacific Missile Range. The 20-flight program, at the same time, is providing targets for Pacific Fleet ships. The program is an extension of preliminary demonstration flights last summer to study feasibility of the target system for Navy use. Flights are being conducted by Chance Vought—which has acquired the U.S. rights to the drone—under a Bureau of Naval Weapons contract. The French CT-41 target missile is to be tested at PMR next month.

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The Missile/Space Week

Shots of the Week

The Army's Martin *Pershing* "shoot and scoot" ballistic missile took two significant steps toward operational status with successful firings at Cape Canaveral April 12 and 17.

Soldiers of Battery A, 2nd Battalion, 44th Artillery from Ft. Sill, Okla., assisted in the first firing and launched the second missile unassisted. Both shots went down the Atlantic Missile Range and impacted within the target areas, the latter after a 200-mile flight.

● After two failures, a joint U.S.-Australian effort to send a two-stage *Aerobee* sounding rocket to measure low-frequency radio wave intensity and spectrum in the ionosphere succeeded April 12. NASA reports that the rocket carried a 144-lb. payload of instruments to an altitude of 125 miles during an 8-minute flight.

NASA Contractors Named

NASA, in one of its first uses of two-phase source selection, has picked two firms—Hughes Aircraft Co. and Space Technology Laboratories—to further compete for the *Pioneer* solar probe development contract.

At the same time, the space agency announced selection of nine firms for various study and support contracts.

Award of the *Pioneer* contract to Hughes or STL is expected in about four weeks. The program calls for development of four spacecraft, with three more planned. First launch is scheduled for early 1965.

Other procurement actions announced by the space agency:

● Avco Corp. and General Electric Co. were chosen to perform two separate $100,000 studies of the *Voyager* spacecraft. The six-month studies will concentrate on a 6000-lb. spacecraft to orbit and land capsules on Venus or Mars. Plans call for launches beginning after 1967.

● GE's *Apollo* support effort was extended to provide plant and test support services at NASA's Mississippi Test Facility. The initial one-year contract is expected to cost about $1.5 million. Depending on negotiations, the extension could run through 1968 with the annual cost growing to $20-25 million.

● GE, Lockheed Missiles & Space Co. and Northrop Corp. have been selected to perform $80,000 first-phase study contracts for the biosatellite program.

In six-week studies, the firms will concentrate on the spacecraft's environmental control, life support, stabilization, re-entry, recovery, sensing, data acquisition and telemetry systems. Phase two of the program, not yet approved, will call for hardware development. The project, to test abilities of primates to withstand long periods of weightlessness, will use a recoverable Earth-orbiting laboratory.

● Radio Corp. of America and Hughes Aircraft were awarded four-month study contracts for the NASA *Synchronous Meteorological Satellite.*

Under a $177,000 contract, RCA will study camera resolution requirements in a synchronous-type orbit employing weather satellite cameras and techniques already developed for the *Tiros* and *Nimbus* programs. It also will study ways to modify a *Tiros* spacecraft launched into a highly eccentric orbit with an apogee of about 22,000 mi. and a perigee of 200 to 300 mi. During the apogee portion of each orbit, cameras in the spacecraft would photograph Earth cloud cover.

Hughes, under a $40,000 contract, will study ways in which the *Syncom I* communications satellite can be modified for installation of weather satellite cameras within certain weight constraints. A *Syncom* so modified could be placed in a 22,300-mi. synchronous orbit to transmit cloud cover pictures of the entire disk of the Earth.

The awards are the second and third study contracts to explore the *SMS* concept. In February, Republic Aviation Corp. began a $136,000 study of the overall *SMS* system.

● Bendix Systems Division received a study contract to compare the behavior of soils in Earth environment with that in "hard" vacuum chambers, in an attempt to simulate certain lunar conditions. Estimated amount of the cost-plus-fixed-fee contract is $27,500.

Martin Gets AEC Contracts

The Nuclear Division of Martin Co. has won two major contracts from the Atomic Energy Commission for design and development of radioactive space power.

A six-month program valued at $167,000 calls for design of a new 40-watt radioisotope electrical system

for NASA's *Interplanetary Monitoring Probe (IMP)* satellites. A second award, for $74,000, covers investigation of a strontium-90 fuel form for use in nuclear space reactors.

NASA has requested that the nuclear power generator be developed to replace solar cells, which are expected to be affected by lack of Sun-orientation and radiation in the *IMP* series, due to begin with launches late this year. SNAP units envisioned for *IMP* would use plutonium-238, a non-fissionable isotope, for fuel.

Gemini-Type Chute Tested

Manned Spacecraft Center engineers have completed eight of an indefinite series of drop tests on a storable gliding parachute.

The test assembly consists of a 24-foot parachute attached to a ⅛-scale *Gemini* spacecraft model. Approximate total weight is 400 lbs., and final descent speeds are about 20 fps.

Helicopters from Fort Hood, Tex., carry the model and parachute to altitudes of 1700-3700 ft. before the assembly is released over Ellington AFB, Tex., which is partially occupied by the Manned Spacecraft Center.

Instrumentation aboard the model includes a remote-radio-control package to deliver commands turning the model into the wind to bring drift velocity to zero.

MSC officials deny that the development is now linked to any specific spacecraft program. However, the arrangement resembles that shown in drawings of the *Gemini* spacecraft proposals for a parachute recovery system to be used if the paraglider deployment problems are not resolved. The parachute is hooked to a cable running lengthwise along the *Gemini's* top surface, outside the cabin, between the two astronaut windows.

Spokesmen describe as a desirable improvement to any landing system provision of enough maneuverability to avoid local obstacles and prevent reduced velocities associated with wind drift. And they predict that development of such a gliding or lifting parachute with suitable turn controls would lead to practical applications related to manned spacecraft.

The tests now under way will determine combined vehicle-parachute dynamics, deployment, and suspension methods. The remote-control system will allow the development of accurate turn-response data and turn-rates.

Cameras mounted in the model are giving the engineers of the Landing and Impact Systems section an idea of what a pilot could see of the system's operation.

U.S., Russia Spar at UN

The U.S. and USSR took separate stands on legal aspects of outer space at the United Nations last week. They differed on several basic points, but the issue pivoted on U.S. intelligence-gathering satellites.

Whether the Soviets will choose to tie agreement on all other issues to this one point is not yet clear. But an informed UN official told M/R that "it is not likely that the point will be resolved during this period."

The other major points of disagreement, he said, "are far more negotiable." These include Soviet proposals which would restrict management of space activities to governments, rather than to private corporations—as is planned in some U.S. programs; consultations between governments prior to launchings; and use of space for so-called "war propaganda" purposes.

Concerning what the Soviets call "cosmic espionage" performed by U.S. satellites, the Soviet position is that this is incompatible with objectives of the peaceful aspects of outer space. The U.S. contends that observation is legal, and that restrictions regarding the military must be dealt with in the disarmament context.

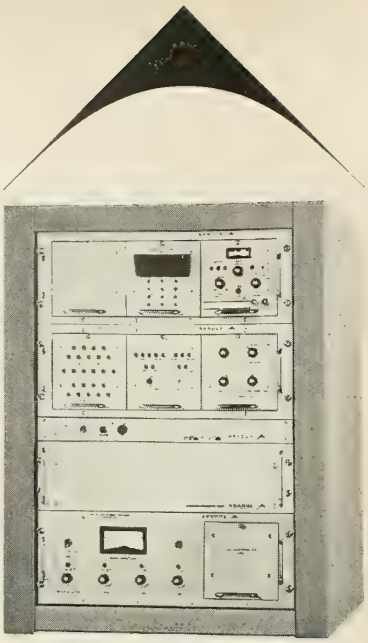
While both the U.S. and Russia agree that the way to implement the peaceful uses concept is through disarmament, the USSR also wants a general statement of the objectives of of the UN Committee on the Peaceful Use of Outer Space to exclude the intelligence satellites.

Military Space Delimited

U.S. military interest in space during the next decade will chiefly involve near-Earth missions, says Dr. Lawrence L. Kavanau, special assistant to the director of defense research and engineering.

Here we may expect to reap the benefits of the intensive efforts in launch-vehicle development now under way," Kavanau declared in a Washington speech, "with the result that today's worries about the mission we can perform with a certain payload capacity will be superseded by the more traditional consideration of what payload weight is required for specific tasks."

Kavanau pointed out that only about half of the space effort budgeted by the Dept. of Defense is connected with today's mission requirements.



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Thiokol Gets Big-Solids Edge

Aerojet, LPC also share booster program; 156-in. and 260-in. motors to be tested

by Frank G. McGuire

LION'S SHARE of the development program for a huge solid rocket booster has been awarded Thiokol Chemical Corp., with portions of the program going to Aerojet-General Corp. and Lockheed Propulsion Co.

The four-phase program will demonstrate the feasibility of 156-in.-dia. and 260-in.-dia. solid rockets using both movable nozzles and jet tabs for thrust vector control.

Phase 1: Demonstration static-firing of a 260-in. solid rocket, half-length, of approximately 3 million lbs. thrust. This phase calls for one such motor to be fired by Aerojet-General and another by Thiokol.

Phase 2: Demonstration static-firing of a 156-in.-dia., 3-million-lb.-thrust, two-segment, solid rocket with a 3-million-lb.-thrust movable nozzle. This motor will be built and fired by Thiokol Chemical Corp.

Phase 3: Static firing of a 156-in.-dia., 1-million-lb.-thrust, single-segment, solid rocket using movable nozzles for thrust vector control. This will be handled by Thiokol Chemical Corp.

Phase 4: Static firings of 156-in.-dia., one million lbs. thrust, single-segment, solid rockets using jet tabs for thrust vector control. This assignment goes to Lockheed Propulsion Co.

Following completion of these tasks, either Aerojet or Thiokol will be selected by USAF to develop a 120-ft., full-length 260-in.-dia. solid rocket with thrust of about 6 million lbs. Solid rocket development is budgeted at $34.3 million for FY '64.

● **Big leg up**—Significance of Thiokol's awards, in the eyes of Air Force and other observers, is that it has pretty well wrapped up three of the four phases and lacks only the phase which it is not advocating. Thus, Thiokol has a "stacked deck" enabling it to qualify for the full-scale follow-on contract with far more big-solid experience than any other firm.

Having fired several demonstration models of the 156-in.-dia. rocket with movable nozzles, and a 260-in.-dia. motor along with Aerojet in phase 1, Thiokol will more than equal Aerojet's experience in this specific program. The weight of such experience should give the company a very good chance of taking the entire package in the next round of competition.



LOCKHEED now enters big-booster field

Aerojet will be under pressure to out-perform Thiokol by a significant margin if it hopes to come up with the major contract in the full-scale program.

● **Locations**—Thiokol plans to carry out its portion of the work from Huntsville, Ala., and Brigham City, Utah, with administrative and technical support furnished by its Alpha and Wasatch Divisions for phases 1 and 2, and Wasatch alone for phase 3.

Aerojet portion of the program will be managed from Sacramento, Calif., with facilities and personnel of the Solid Rocket Plant.

Lockheed efforts will be conducted near Redlands, Calif.

Thiokol also will conduct work at its Camden, Ga., site, and Aerojet will use its Dade County, Fla., facility.

The Defense Department announcement said the 156-in.-dia. segmented demonstration motor "has particular military significant since it represents the largest size motor that can be built at existing manufacturing sites and shipped by rail and truck throughout the United States.

"This motor alone would weigh approximately 25 times as much as a complete *Minuteman* missile."

Designated Program 623A, the effort ultimately will aim at placement of up to one million lbs. in Earth orbit. Noteworthy in the contract announcement is the fact that only Phase 4, the Lockheed portion of the program, calls for more than one motor firing by a contractor in that phase. In each of the other phases, each contractor will fire only one motor.

An estimated $60 million is involved in the present overall 623A effort, with the FY'64 budget placed at $34.3 million.

For Aerojet, the contract awards mean a smaller portion of the overall package than had been originally anticipated, while Thiokol landed in three of four possible categories. Lockheed, although producing the *Apollo* escape motor and other solid rockets, is now effectively in the large booster field for the first time with the 623A program.

Aerojet recently conferred with shipbuilding and other firms experienced in large metal structures with a view toward having them participate in the large solid rocket program. It outlined for the metal-fabricating firms the problems propulsion companies face in fabrication, handling and transport of big motors (M/R, Jan. 28, p. 28).

Over a dozen firms attended the Aerojet meeting, which covered X-ray,

radiographic and hydrotest procedures used in solid rocket production, as well as high-strength steels and other special metals involved in case fabrication.

Both Aerojet's Dade County facility and the Thiokol site in Camden, Ga., are on waterways and cover considerable acreage—Aerojet's is 75,000 acres and Thiokol's 50,000 acres.

Lockheed expects to use a 9100-acre site at Potrero, near its Redlands, Calif., headquarters, for the Phase 4 work under Program 623A.

● **Facility squeeze**—The prospect that all large solid rocket work will be done in company-owned facilities has put the squeeze on propulsion companies to develop their own facilities—with more than the usual risk.

This development—caused by lack of funding for any government-financed plants—puts industry in the position of building required facilities as a prerequisite to bidding on the contract, with no guarantee of getting the award (M/R, Dec. 24, p. 19). The Air Force wants maximum use to be made of existing facilities such as propellant plants, personnel and hardware.

Those firms having maximum transportability built into the fabrication site, such as those on waterways or the ocean, will be ahead of the game throughout the development period of large solid rockets, unless a drastic solution is found to the transportability problem (M/R, Mar. 4, p. 16). This will be particularly true during the later phases of the program, involving the full-scale 260-in. motors.

● **AF is coy**—Despite the obvious import of the program, the Air Force has refused to describe it as a new breed of booster, and shies away from the term *Nova*. It says the program is to demonstrate the feasibility of huge solid rockets. Simultaneously, the Air Force will benefit from the *Titan III* effort.

Technical progress realized during the program probably will determine how many future full-scale 260-in. firings will be carried out before feasibility is considered fully demonstrated and further work is contracted for. AF and NASA officials have said the potential now exists for design and fabrication of 300-to-325-in.-dia. motors.

● **Management**—The large solid rocket program grew out of the November, 1962, DOD/NASA agreement on large space boosters. Program direction will be handled by the Air Force Systems Command's Space Systems Division, Inglewood, Calif., and NASA requirements will be cranked into the management aspects. NASA's needs to date have been generalized, but they nominally call for a unit of six to seven million lbs. thrust and a final vehicle made up of a cluster of four motors.

Subcontracting in the program may be handled largely by the main contractors, but the Air Force probably will break out major portions for separate contracting. If this pattern is followed, it will parallel the method used in the 100-in.-dia. program during the past 18 months.

● **Impact**—Aerojet-General, somewhat disappointed over its assigned role in the program, is determined to prove that large solid rockets have a definite role in the nation's space program. The company's program manager says engineering work will be done in Sacramento, heavy fabrication will be subcontracted, and the completed chamber will be barged to Dade County for propellant loading, final assembly and test firing.

"We haven't waited idly for these contract awards," he said, "We spent our own funds to build a rocket chamber 280 inches in diameter to prove the shipbuilding industry can fabricate these giant chambers to the precise tolerances of the Space Age. This same chamber, now at Sun Shipyard in Chester, Pa., will be shipped by barge to Florida to prove our transportation theories. I figure we're six months ahead of schedule because of this investment."

He said all construction necessary for commencing the just-contracted work on the big solid rockets will be finished by November, while all work the company now plans for the Dade County site will be finished by May, 1964. The new plant site will represent a $10-million investment and will employ 250 people within the next year. Of these, 25 will be transferred from Sacramento and the remainder hired locally. The contract award will have no significant effect on the Sacramento employment.

Similarly, Thiokol expects to have a $10.5-million investment in its plant, will have most of its work complete by next spring, and will have 450 employes within a year. Thiokol is expected to become one of Georgia's largest industrial employers. The exact location of the site, more fitting for its Utah operations, is Horse Pen Bluff.

Lockheed's Potrero facility, one of three company locations near Redlands, is equipped with a 2-million-lb.-thrust test stand, a non-destructive test facility, a conditioning oven complex, and supporting personnel and instrumentation bunkers.

LPC is planning construction of a 300-gallon vertical propellant mixer and other facilities for the 156-in.-dia. motor work.

The 600-employee company, located 65 miles east of Los Angeles, is a wholly owned subsidiary of Lockheed Aircraft Corp. Its previous large booster work includes last year's firing of a segmented 120-in.-dia. solid rocket, 34 ft. long, which developed 400,000 lbs. of thrust during its 130-sec. burning time. ■

Titan II Expected to Overcome 'Pogo-Stick' Trouble

VIBRATION PROBLEMS causing a pogo-stick effect during flight of the *Titan II* booster are expected to be solved through continuing effort in the development program.

It will be "well within tolerable limits" by the time *Gemini* flights are scheduled to use the vehicle, a program spokesman told M/R.

"The problem is not so bad as it looks," the spokesman said, "but the fix is always harder than the diagnosis." He explained that the booster's natural frequency is 11 cps, which offers no problem until the lower portion of the bird "decides to sing harmony." The "harmony" then causes elastic motion along the longitudinal axis.

The anticipated fix of the problem includes increasing pressure within the propellant tanks, thus damping out the vibrations. Every large booster has the same problem, the source said, and various fixes have been used. The *Titan II* propellant tankage is now pressurized far below its maximum capability, and boosting it a few psi is expected to achieve the desired effect.

"If we had our choice, this is the kind of problem we'd prefer to have, rather than some major catastrophe like structural weaknesses," the *Titan II* spokesman claimed.

The problem stems from a combination of factors, including pump vibration, pressure in the propellant system, and flow rates, as well as the volume of fluids within the tanks. Engine combustion instability has been ruled out as a cause. The overall combination of factors thus introduces the resonance problems.

The *Titan II*, which normally "flies like a javelin," eventually develops a slack/taut movement about one minute after liftoff. This condition continues for 10 to 20 seconds, but not at the point of maximum aerodynamic stress.

Flight of M-1 Delayed Three Years

New-look Aerojet engine will have increased thrust, new cooling; more ambitious missions envisioned

by Hal Taylor

A NEW NASA development schedule will delay actual flights of Aerojet-General's M-1 engine until 1969 or later.

Other program goals call for component testing over the next 18 months; first engine test late next year; and completion of its Preliminary Flight Rating Test by a 1967 target date.

The stretchout, however, will not lower the program's total pricetag. Instead, the contract between NASA and Aerojet will be worth about $230 million, compared with the original estimate of $90 million.

Prime cause for the sharp price boost is a major design change which uprates the liquid-hydrogen engine's thrust from 1.2 million to 1.5 million lbs. Design features providing for even greater thrust and performance and a longer testing schedule also added to the cost.

● **New look**—The new program was revealed to MISSILES AND ROCKETS by A. O. Tishler, NASA's liquid propulsion chief.

"It will produce a more reliable booster," he declared, adding that the M-1 is now a far different engine from the one proposed by Aerojet in early 1962. In addition to its increased thrust, he said, the new M-1 boasts a completely new cooling system. The fuel pump also will have a increased capability through use of a two-stage turbine delivering higher flow and pressure.

Tishler said the program is now on a minimum-cost schedule, under which space agency funding will be spread out over a much longer period than was originally planned.

Currently, much of the NASA/Aerojet effort is focused on development of facilities and initiation of component testing. Tests already have begun on the gas generator. The liquid-oxygen pump will be tested in late 1963, and tests on the thrust chamber and hydrogen pump are set for early 1964.

When the program was announced in April, 1962, NASA's plans called for delivery of the first M-1 engines in 1965, with flights in 1967. Under the new schedule, delivery will not begin until about 1968, and actual flights could easily slip into the 1970's.

The decision to slow the program's pace followed selection of lunar orbit rendezvous, using the *Saturn V* booster, for Project *Apollo* missions. This permitted NASA to delay work on the *Nova* booster, for which the M-1 originally was designed.

● **Future jobs**—NASA now plans to use the M-1 as an upper-stage powerplant in post-*Saturn* launch vehicles. Contemplated missions include orbital space stations, manned interplanetary flights and deep-space flights.

The mission would require low-orbit payloads ranging from 500,000 to 2 million lbs., with launches in the 1970-1980 period—well within the M-1's development schedule.

In addition to providing for better performance and more reliability, the new M-1 program expanded the range of its potential uses.

Two Aerojet officials, Dr. J. C. Moise and D. E. Price, declared in a paper presented to a meeting of the Society of Automotive Engineers in Washington, D.C., that M-1 could be converted for use as a first-stage powerplant for future space boosters.

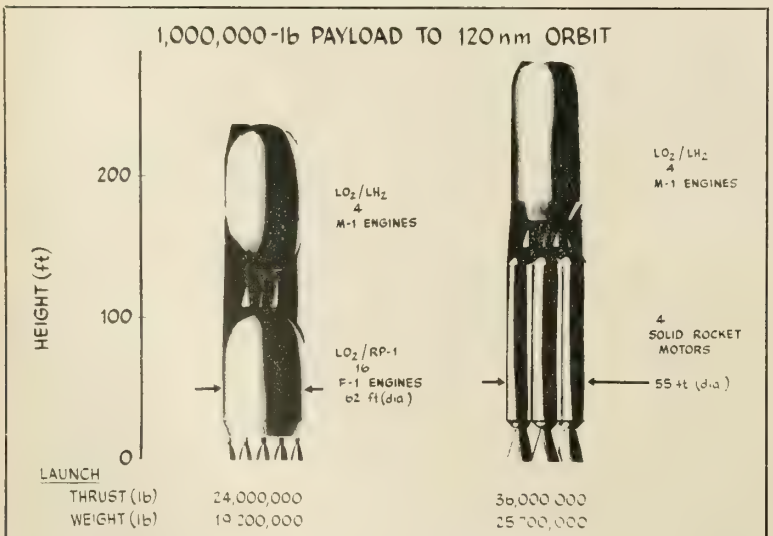
The first-stage M-1, they predicted, would develop 1.2 million lbs. of sea-level thrust, with a potentional uprating to 1.5 million lbs. of thrust. The converter engine would require a thrust chamber with a smaller nozzle expansion ratio.

The launch vehicle would have 14 M-1 engines in the first stage, and only one M-1 in the second stage. If the higher-rated engine were used, only 12 engines would be needed for the first stage.

With a maximum diameter of 73 ft., the vehicle would be able to put a 1-million-lb. payload into a 120-n.-mi. orbit. The launch vehicle would have a total thrust of 17 million lbs., weighing only 13.6 million lbs.

The major advantages of such a vehicle, the Aerojet officials said, are the single-engine second stage; low sea-level thrust; use of the same propellant in all stages; and low liftoff weight.

The main use of the M-1 continues to be as a second-stage powerplant, pro-



BOOSTER CANDIDATES for U.S. space missions during post-Saturn period.

viding more than 45% more payload capability than upper stages powered by conventional liquid-oxygen/kerosene stages.

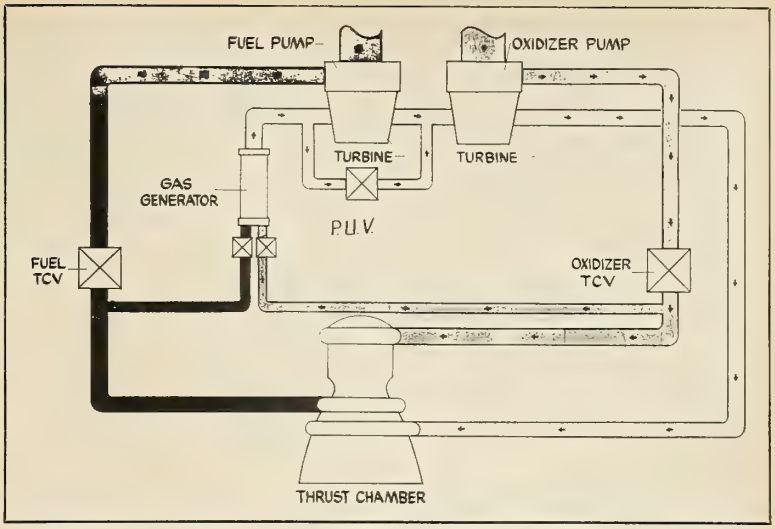
A four-M-1-engine second stage, coupled with a first stage powered either by 16 F-1 liquid-oxygen/kerosene engines or four solid-fuel motors, would again be able to place a million-lb. payload into a 120-mile orbit. The escape payload for lunar or planetary flights would be 400,000 lbs.

● **Operation**—The Moise-Price paper also provides the first details of the engine's design and operating characteristics.

Propellants are supplied to the thrust chamber by separate fuel and oxidizer turbopump assemblies. The fuel pump is a multi-stage axial flow pump and the oxidizer pump a single-stage centrifugal pump. Both pumps are mounted on the regeneratively cooled thrust chamber and each pump is driven by its own gas turbine.

A fuel-rich fluid-hydrogen/liquid-oxygen gas generator supplies the turbine drive gases in series: first to the fuel pump turbine; then to the oxidizer pump turbine. More than 100,000 shaft hp is delivered by the turbopump assemblies. The liquid-hydrogen pump is said to have about three times as much shaft horsepower as any other liquid rocket engine turbopump under development.

In addition to providing turbine power, the gases are utilized for two other purposes: to cool the thrust chamber nozzle skirt, and to provide additional thrust as it is exhausted through small nozzles at the main nozzle exit plane. The regenerative coolant tubes extend along the DeLaval-contoured nozzle to the point at which the nozzle is cooled by turbine exhaust gases. The engine is gimbaled to provide thrust-vector-control capability.



SCHEMATIC SHOWS fluid flow of Aerojet-General's M-1 liquid-hydrogen engine.

The engine-starting sequence is initiated electrically. At the start signal, the thrust-chamber and the gas-generator spark igniters are energized. High-pressure helium opens the main propellant thrust chamber valves. As the turbines accelerate, the pumps supply fuel and oxidizer to the gas generator and the thrust chamber. Propellants entering the thrust chamber are ignited by the previously energized ignition system. Gas generator exhaust gases accelerate the turbines to their steady-state operating condition. More than 1½ tons of propellant per second are consumed during this steady-state operation. Engine shutdown is effected by venting the gas generator valve and the thrust chamber valve actuators. This allows valve spring forces to close the propellant valves to both units, shutting off the flow of propellants and terminating engine operation. ■

F-1 Engine Needs 200 More Test-firing Successes

SIX TO EIGHT more months of testing will be required on NASA's F-1 engine before the space agency can make firm scheduling commitments for the *Saturn V* booster.

A top NASA official declared that during that period some 200 successful firing tests of the 1.5-million-lb.-thrust engine will have to take place before the NASA can ensure that its combustion instability problem has been licked.

Although NASA has maintained that the engine's problems would not delay its lunar-landing program, it is known that the F-1 has missed the target date for its preliminary flight-rating test.

Originally set for March, the test now will be achieved later this year.

It also appears certain that delivery of the engines will not begin as scheduled later this year. If delivery is put off until 1964, it will leave little more than two years for the vast amount of development work required to mate the F-1 into *Saturn V* first stages in time for its scheduled 1966 launching date.

Commenting on the current test program, the official said that the F-1 is doing "pretty well" and no trouble has cropped up recently. But he said the testing program will have to continue for at least one more year.

He said a minimum of six to eight months of testing would be required to inspire enough confidence in the engine's operation and to firm up development and delivery schedules.

Earlier, NASA officials reported that thus far the combustion instability problem cropped up in only seven out of 250 firings.

● **New measures**—The space agency is currently attacking the problem in three main areas:

—It is fabricating a redesigned injector—the component which mixes the liquid oxygen and kerosene. These units are being test-fired in thrust chambers and engine test stands.

—It is redesigning the dome through which the liquid oxygen flows to provide a smoother flow and to damp out pressure oscillations.

—A special kind of hole—called a cavitating venturi—is being introduced in the injector. This should prevent oscillations from the combustion gases from feeding back into the liquid oxygen.

The injector is considered by NASA to be one of the most likely causes of the instability. The usual way of conquering the problem is to change its design by changing the location or size of the injector holes.

The F-1 is being developed for NASA by the Rocketdyne Div. of North American Aviation, Inc. Tests on the engine are held at NASA's Edwards AFB facility in California.

Five F-1 engines with a total thrust of 7.5 million lbs. will make up the first stage of the *Saturn V* booster. Prime contractor for the booster stage is the Boeing Co.

Boston Center Finds Capitol Critics

Congress asks if NASA electronics facility is needed and whether it can be staffed; Boston location questioned

by William Beller

NASA'S PROPOSAL to establish an electronics research center in Boston is running into some opposition in current Congressional budget authorization hearings.

Suspicions that political pressures might have influenced NASA to choose Boston as the site were briefly aired when Charles A. Mosher (R-Ohio) of the House Space Committee indicated there was room for questioning any installation suddenly placed in Massachusetts after "certain promises made by the Democratic candidate for the Senate."

Senator Clifford P. Case (R-N.J.) said last week he is not convinced after discussing the matter with space agency officials that the electronics center is needed. Case is a member of the Senate Space Committee, which will probably hold hearings late this month.

● **Three issues**—The House Space Sciences Subcommittee, chaired by Joseph E. Karth (D-Minn.), was concerned with three basic questions:

—In view of existing electronics research facilities in the nation, including those already within NASA, does the agency still need its own electronics center?

—If a need can be shown for such a NASA facility, can it be staffed in the face of the shortage of qualified researchers?

—If there *is* a need that *can* be satisfied, where is the best location for the facility?

NASA's proposal calls for a $50-million center in the Boston area (M/R, March 18, p. 16). It would be fully staffed by 1968-69 with about 2000 persons—600-700 of them electronics research scientists. An initial authorization of $5 million is being asked—$3 million for land acquisition, $2 million for design and engineering services.

The facility is to be developed as the research electronics arm of NASA. It is expected to take the form of other NASA centers such as Langley and Ames.

Supporting the need for the center, Albert J. Kelley, NASA's director of electronics and control, testified that while, on an across-the-board basis, approximately 60% of NASA's dollars are spent on electronics, 90% of flight failures are blamed on the electronics.

Breaking down his cost figures, Kelley said launch vehicles average about 40% electronics, a development vehicle could go as high as 60%, a spacecraft about 70%, and ground-base track and data systems average about 90%.

When the center reaches full strength, its annual budget for salaries and operation will be $28 million, NASA estimated. This figure was severely challenged by a subcommittee member who said the Air Force's Rome Air Development Center, N.Y., with 1600 people cost $54 million to operate in Fiscal 1962; and the Aeronautical Systems Div. of Air Force Systems Command, with only 600 professional people, cost $75 million in operational money for the same period.

● **Is it needed?**—There is some feeling that what NASA really needs most is an effective information-retrieval system. This was the point of questions asked by the subcommittee but based on an earlier Senate committee study.

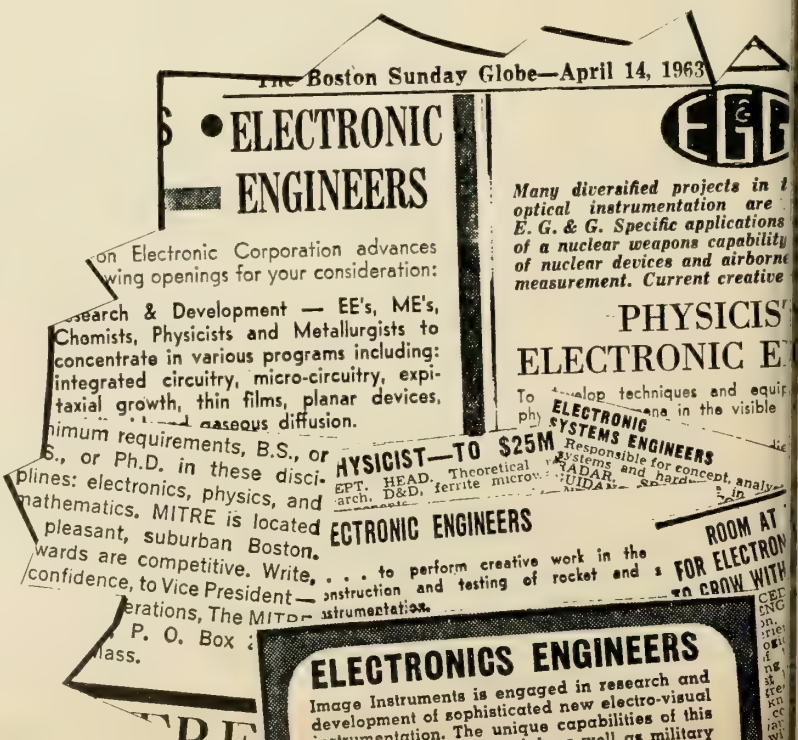
After this study, it was reported that at least one-tenth of Federally supported electronic research and development may consist of "unwitting needless duplication of effort." The waste may add up to $200 million out of $2 billion expended for this type of work, the report said.

No one really knows who is doing what, where and how in the vast array of Defense and NASA electronics work, the Senate study stated. Results: programs crucial to the nation's security do not attain their highest and promptest yield, and the cost of the work is raised significantly.

Kelley assured the subcommittee, however, that NASA's new information retrieval service gives rapid access to technical reports.

In Fiscal 1960—the latest date for which complete figures are available—the government spent more than $2 billion in sponsored electronics research and development. This money, spent by

HELP-WANTED ads in Boston paper point up problem of recruiting personnel.



the military services, National Bureau of Standards, Federal Aviation Agency, Atomic Energy Commission and NASA, went to industry, government laboratories and non-profit institutions.

Kelley insisted that additional money should go into a concerted effort in space electronics. He said that the Army addresses itself to battlefield problems in electronics, the Navy to ASW problems, and the Air Force to its own particular requirements. The NASA electronics center would handle space electronics—the new phase of the work.

The subcommittee was not convinced, however, that this work was entirely new. It pointed out that an important group from the Naval Research Laboratory was incorporated into NASA when it was first formed. This was the Project *Vanguard* group which became the nucleus of Goddard Space Flight Center. Committee members ran down a list of government research laboratories, several of which, Kelley volunteered, were working on NASA contracts.

Kelley maintained, nevertheless, that NASA needs an "in-house competence to be able to evaluate the results of ourselves and others, and . . . we feel the best way to do this is with people who are getting their fingers dirty, if you will—who understand the real live problems."

Kelley did not discuss what NASA is doing now to evaluate the electronics work of its contractors. Nor did he say explicitly whether the center would do basic research, applied research, contract monitoring, or all three.

Opponents suggested that a highly professional staff would not be content simply with contract monitoring and checking, but would want to do some of the research work themselves. This could bring problems because "it's a rare scientist who can simultaneously umpire and be at bat," one said.

● **Can it be staffed?**—One Congressman held that obtaining the professional staff will be the toughest part of setting up the center.

Of the 2000 people anticipated for the center's payroll, between 600 and 700 are to be electronics professionals. This is in addition to the 391 such specialists Kelley said are scattered throughout NASA today.

"Our intention is to leave the work at the existing centers largely as it is, and this (center) is an additional build-up within the agency," he testified. This means "some of the research should be done in close association with the project as well as . . . at the electronics research center."

To bring the center up to strength, Kelley expects some professionals will come from universities, some from industry, and a substantial number fresh from universities. He stated that the center is for the "long haul" and the personnel build-up will be gradual. The center may, though, have some impact on *Apollo*, he said.

A committee member observed that with government pay schedules relatively low, NASA may find itself spending vast sums of money training electronics specialists simply for the higher-paying industrial jobs. Kelley held out the lure of "responsibilities and challenges" in government service.

A Congressman observed that the U.S. is going to be short about 60,000 technical people in electronics. The figure is based on a survey conducted jointly by the Office of Electronics, Office of the Director of Defense Research & Engineering; and the Electronic Industries Association.

The survey revealed that in 1961 about 150,000 scientists and engineers were engaged in electronics work in the U.S. Approximately 120,000, or 80%, were in government-supported work, mainly for agencies of the Department of Defense.

The picture projected to 1965-67 showed the demand for electronics technical people increasing as much as 30% to 40%. NASA's expanding space program was expected to add to the burden.

Basing his comments on the 1961 level of productivity, J. M. Bridges, director of the Office of Electronics, said in the report that the period 1965-67 will call for 40% more engineers and scientists in electronics than will be available in this country. "We are going to be short 50,000 to 70,000 technical people in electronics," he said.

● **Is there another Boston?**—NASA feels so strongly that Boston is the place for the center that the agency is not recommending a second choice. There is a question as to whether NASA would even want the facility if it were located elsewhere. This came out when Kelley testified that the site of the installation is of the same importance as the need for it.

He dismissed other locations by saying, ". . . we wouldn't try to build an orchid in the desert for we might have to build a hot-house to go along with it."

Boston was admittedly chosen because it houses MIT and Harvard. Their graduates are expected to be likely candidates for jobs at the center, and employees at the center would be encouraged to pursue advanced studies at the institutions. The university atmosphere is held in high esteem by NASA, as well as by many research organizations who settle within commuting distance.

There is a degree of precedence for NASA's action. The Jet Propulsion laboratory, for instance, was selected as a NASA facility principally because of the academic climate furnished by the California Institute of Technology.

Kelley said that, though other areas in the country were considered and their universities evaluated, "I think historically (MIT and Harvard) have proven the best."

The NASA spokesman said the Boston selection was based on technical grounds alone. Factors such as economics, competition for personnel, geography and vulnerability to enemy attack were not considered.

The subcommittee prodded to see whether other locations might hold added advantages. Karth pointed out that on a dollar basis about 90% of the overall electronics work done on the East Coast is on a narrow band drawn from New York State south through New Jersey and across Washington, D.C. Only about six or seven percent is done in the Boston area.

Kelley argued, however, that much of this work is production and is for consumer products. He suggested that emphasis be put on the phrase, "research and advanced technology."

When California was suggested, Kelley maintained that the facilities there, although sufficiently in the research field, are too scattered to form the electronics complex needed. He affirmed that NASA wants a tightly packed, research-oriented municipality containing Harvard and MIT—and implied that the agency would be willing to accept any location in the U.S. that fulfilled this criterion. ■

GOVERNMENT-SPONSORED ELECTRONICS R&D EXPENDITURES FY 1960
(thousands of dollars)

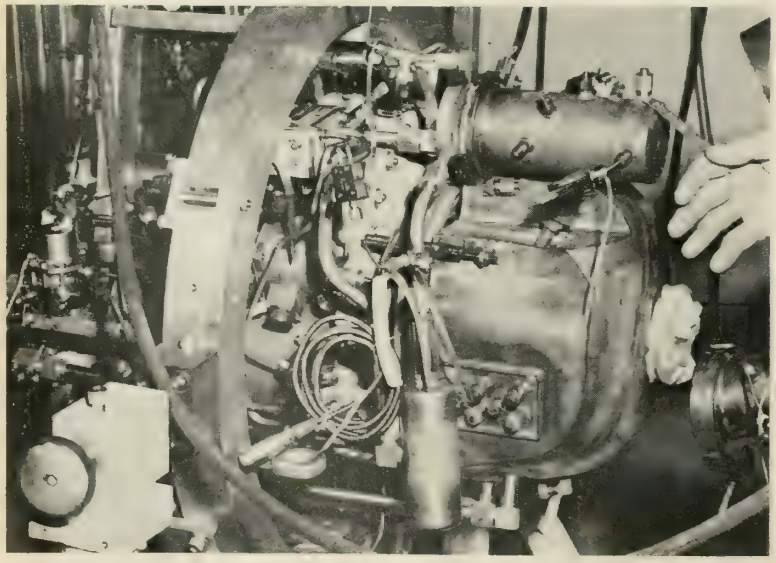
	Government Laboratories	Industry	Universities & Non-Profit Institutions	Total
Army	71,000	335,000	17,000	423,000
Navy	100,000	600,000	32,000	732,000
Air Force	57,000	680,000	37,000	774,000
NBS	4,500			4,500
FAA	3,750*	25,500*	750*	30,000
AEC	distribution not available			30,000
NASA	10,300	10,400	4,000	24,700
				$2,018,200

* Estimated distribution based on numbers of contracts let to industry and institutions.









The News In Pictures

TOP LEFT: *Experimental space suit is tested by engineer on bike at Republic Aviation Corp.'s Farmingdale, L.I., N.Y. laboratory. Suit is being used to obtain data for NASA's Project Apollo space suit program.* **TOP RIGHT:** *Successful April 12 firing of Army's Martin Pershing tactical missile at Cape Canaveral was first in which soldiers took part. A few days later, on April 17, another Pershing was launched by an all-Army crew. It travelled some 200 mi. on a medium-range mission down the Atlantic Missile Range and impacted within 300 meters of its target.* **CENTER LEFT:** *The ARIS (Advanced Range Instrumentation Ship) Gen. H. H. Arnold docks at Port Canaveral April 13 after shakedown cruise from Bayonne, N. J. Second of two ARIS ships for AMR, the Arnold, named for the World War II Air Force chief, will be dedicated at the Cape on May 1.* **BOTTOM LEFT:** *Accessory power unit for X-20 (Dyna-Soar) manned glider was shipped recently to the Boeing Co. by Sundstrand Aviation-Denver. It's the first hydrogen/oxygen-fueled, turbine-driven space power system for an orbital manned vehicle.*

Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand—getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at $\gamma = -6°$ to touchdown?

Curves Provide Key

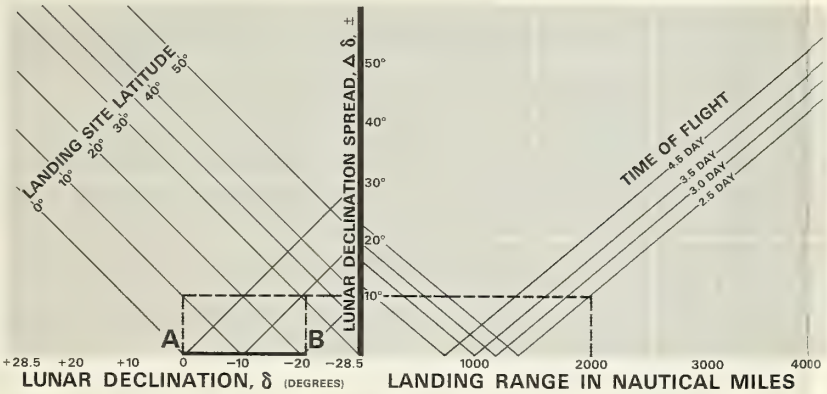
The curves at upper right provide the key. Window AB describes the range of lunar declinations, from $+0.5°$ to $-20.5°$, acceptable for returning to an earth landing site at a latitude of $+10°$, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at $\gamma = -6°$ to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of $-10°$. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

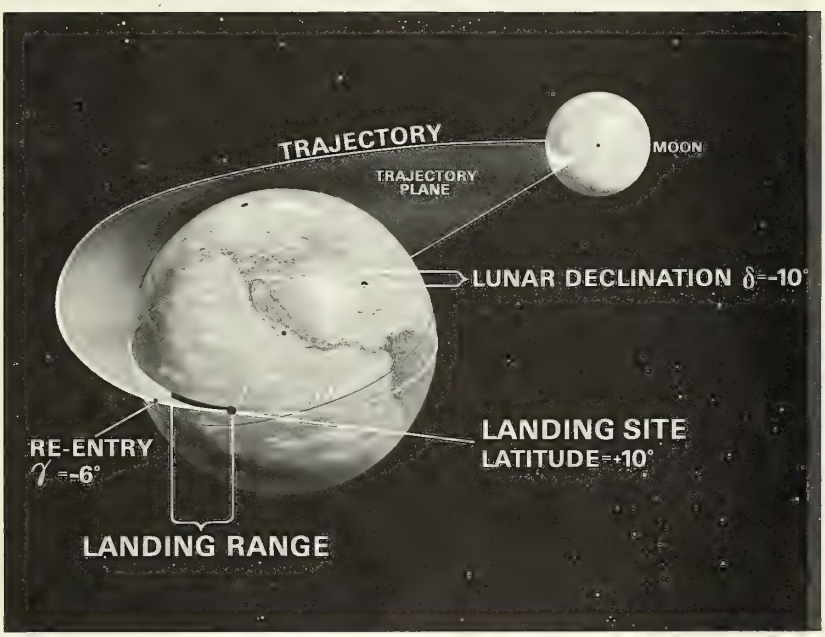
Variety of Opportunities

At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far-ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.

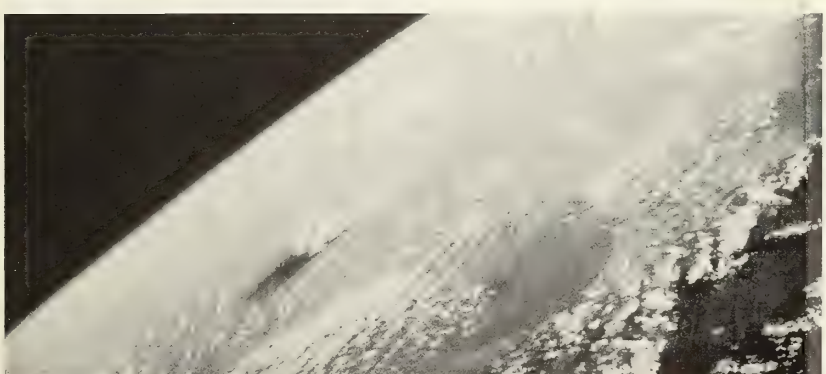
Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics|Astronautics, 5833 Kearny Villa Road, San Diego 12, Calif.





LUNAR LIFT OFF AT $\delta = -10°$ *Heading for an earth landing site latitude of $+10°$, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from $\gamma = -6°$ to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

GD

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GENERAL DYNAMICS | ASTRONAUTICS

A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTIST

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

INERTIAL GUIDANCE

BS degree in physics, EE or ME and 2 to 5 years of experience in one or more of the following:

TECHNICAL ANALYSIS: scope includes establishment of guidance and flight control system requirements, analysis of system performance, establishment of test parameters and initiation of design changes.

AUTOPILOT DESIGN: assist in the detail design and development of the Centaur space vehicle flight control system. The system includes the autopilot, programming devices, and passive tracking equipment. The designer is also responsible for design of necessary test equipment.

GUIDANCE SYSTEM: requires individual with design and fabrication experience for subcontractor control and to assure that the delivered guidance system is accurate and reliable. To achieve this goal, the tasks range from purest analytical study to configuration control.

DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability, or both.

Tasks involve TECHNIQUE DEVELOPMENT in the following:

SYSTEMS: User-Operations Analysis, Reliable System Design, System Reliability Models, Cost-Effectiveness Evaluation, Man-Machine System Analysis;

COMPONENTS: Reliable Hardware Design, Hardware Analytic Evaluation, Component Evaluation, Parts and Materials Selection, Specification Criteria, Supplier Programs and Evaluation.

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

EXPLORE THE IDEA of growt and advancement with one of th nation's prime aerospace firms, company whose name is synon mous with leadership in a broa range of pace-setting industrial a tivities. Among dozens of activ study contracts and in-process hard ware projects which assure far-rang ing challenges to Astronautics sta members are Nova, Centaur, Atla SLV III, lunar vehicles, manne space stations, solar monitors an an impressive array of orbiting an space probe vehicles. Consider th scope of these projects. Match you interests and abilities with the activ ity descriptions at left. Visualiz yourself at Astronautics, where th professional climate favors your ca reer and the sunny San Diego cli mate favors your family's year-roun enjoyment of life.



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**If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5833 Kearny Villa Road, San Diego 12, California.*

Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, OPERATIONS AND SYSTEMS ANALYSIS, WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS AND CALIBRATION LABORATORIES, and TECHNICAL WRITING.

GD

GENERAL DYNAMICS | ASTRONAUTICS

AN EQUAL OPPORTUNITY EMPLOYER

Technical Countdown

ELECTRONICS

Tiny Real Time Computer Perfected

General Electric is developing a microminiature, real-time, general-purpose computer based on its operational M-236 unit. The miniature A-236 will have functional organization and capability identical to that of the microelectronic member of the M-236 computer family. While size, weight and power vary with system needs, GE says it can supply a range of models dependent on memory requirements. An A-236 designed for a 4096-36 bit word memory would have a volume of 900 in.^{3}, weight 32 lbs. and require 150 watts of prime power. A demonstration model will be in operation at GE's Light Military Electronics Dept. before the end of the year.

Maser Activity in Four Gas Systems

Scientists at the Bell Telephone Laboratories have observed optical maser oscillation in four new gas systems—nitrogen, bromine, carbon monoxide and sulphur hexafluoride. In addition, the number of frequencies emitted by noble gas lasers has been raised to better than 150. The four new gas laser systems use a mechanism called "dissociative excitation transfer," in which a polyatomic molecule containing the required atom is broken up in such a way that the atom attains an excited state conducive to laser operation. Wavelengths in the polyatomic devices range from 0.8446 to 5.5971 microns.

Saturn May Use Fairchild's DECOR

The feasibility of performing the *Saturn* altimeter function using the Fairchild Stratos Digital Electronic Continuous Ranging (DECOR) system will be investigated by the firm under an $80,000 study contract from NASA. The contract calls for the submission of a prototype design and a performance assurance plan to the space agency after extensive analysis. DECOR is a Fairchild-developed digital radar range-measuring system.

Fuel Cells At Allis-Chalmers Bolstered

Two government contracts totalling $420,900 have been let to Allis-Chalmers for research and development work into deep-space fuel cell applications. One Air Force contract calls for design, fabrication and evaluation of several self-contained fuel cell systems. The other, a $219,600 contract extension from NASA's Marshall Space Flight Center, covers additional design work on fuel cell systems.

Test Program Leads to Five-Year Reliability

A two-part program performed by General Electric Spacecraft Dept. under Air Force sponsorship has demonstrated the feasibility of achieving long-life-in-space reliability in spacecraft equipment. The levels obtainable run from one to five years. The first phase of the program consists of component testing; the second covers high-reliability parts evaluation and application. This second phase is generating an entirely new system of reliability controls reaching back to the parts and materials level. GE representatives surveyed and selected manufacturers as procurement sources, and have already purchased some 38,000 fully controlled parts. The test program is continuing, and more than 5000 parts have been in test for more than 13 million part-test-hours. The collected data will be used to provide methods of determining the time-to-first-failure for parts used in the space environment.

New Capacitor Advance Claimed

An extremely small and lightweight bulk tantalum capacitor which uses no electrolyte has been developed by General Instruments Corp. The device, which operates at working voltages to 125v and at temperatures between —100°C and +125°C, is formed by deposition of a thin film of tantalum-pentoxide over the basic tantalum wire. The oxide layer, which serves as the dielectric, is said to be free of "pinholes," allowing use of a metallic cathode connection rather than an electrolytic or semiconductive method. This removes instabilities normally caused by electrolytic ionization. The firm says the .0006-cu.-in., .004-oz. component can "replace at least five other capacitor types, and is equal in performance to Mylar devices 10 times its size."

MATERIALS

Large Zinc Oxide Crystals Grown

Large crystals of zinc oxide are being grown at Bell Telephone Labs in a controllable process involving seed plates hung in dilute basic solutions of the oxide at high temperatures and pressures. Zinc oxide is both a semiconductor and a piezoelectric and the artificially grown crystals reach sizes ⅜ in. thick and ¾ in. long.

PROPULSION

Solid Rocket Sterilization

Sterilization of solid rocket motors to prevent contamination of the Moon or other planets can be accomplished by adding ethylene oxide as a sterilant to a propellant mixture of polyurethane and amonium perchlorate, say scientists at California Institute of Technology's Jet Propulsion Laboratory. Current solid motors cannot be sterilized by heat treating, and the fact that they may not consume all propellant eliminates burning as a means of sterilization.

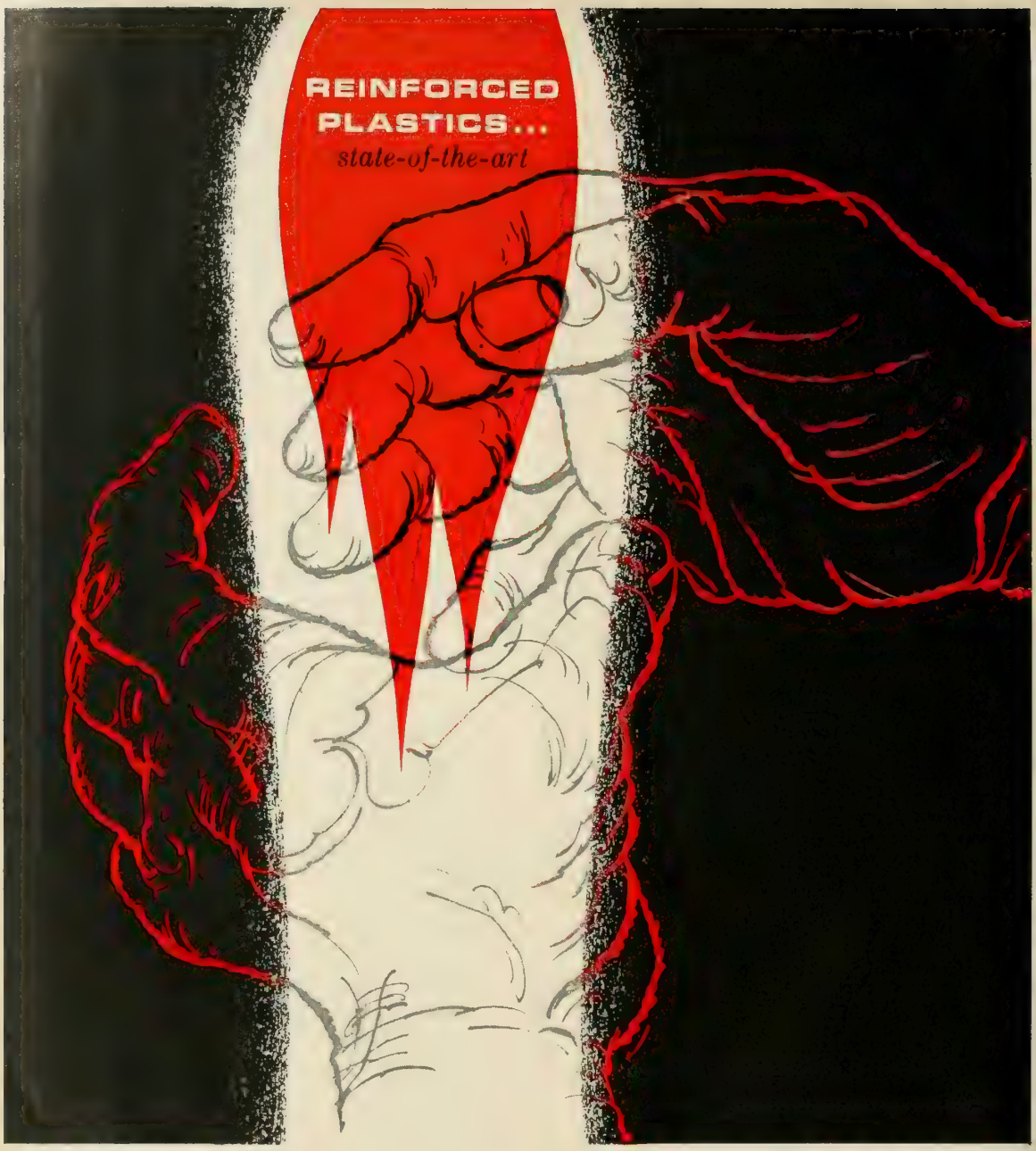
EOS to Develop NASA Engine

Electro-Optical Systems, Inc. will develop the engine, propellant-feed system, storage tank and controls for a gas-discharge ion-rocket engine under a $477,969 contract from NASA's Lewis Research Center. A flight prototype is to be delivered to NASA by the end of the one-year contract. EOS has studied the electron-bombardment system under previous contracts. The unit generates ionized cesium in an arc, rather than by electron stripping through contact means. The new contract also provides for studies of scale-up and clustering.

SPACE MEDICINE

Chlorophyll/Oxygen Relationship Found

There is no simple relationship between the chlorphyll content and the oxygen-evolving activity in photosynthetic systems, according to biochemists at Armour Research Foundation of the Illinois Institute of Technology. But the researchers found a significant relationship between oxygen production and the ratio of chlorophyll to protein content and the size of chloroplast fragments. The most active oxygen producers of these fragments were ones which were about 1/50 the size of whole chloroplasts.



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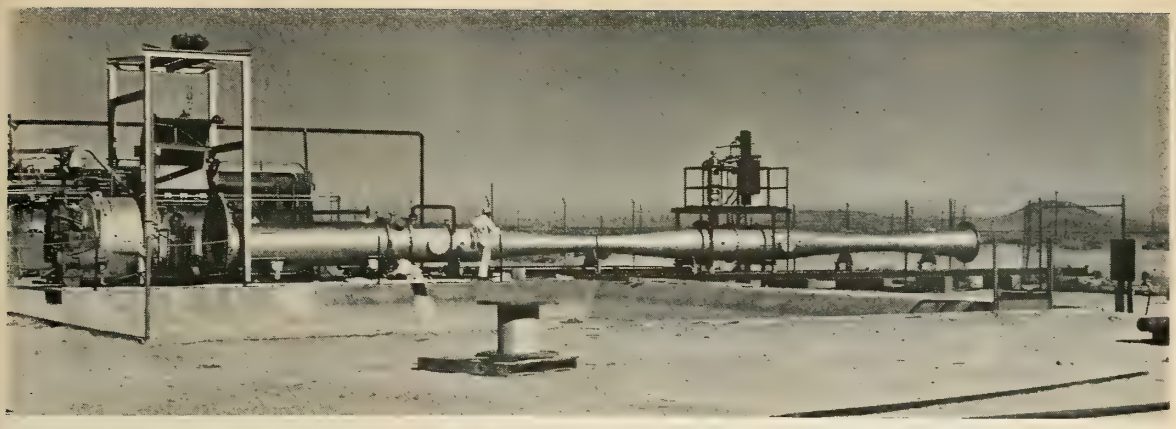
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HYPROX GENERATOR (on scaffold at right center) powers ejector duct of JPL altitude test chamber (at left).

propulsion engineering

Hyprox To Cut Altitude Chamber Cost

An exclusive report on $128,500 Thiokol steam generator already in use at JPL

by Russell Hawkes

EDWARDS AFB, CALIF.—A rocket test chamber here is ejection-pumped to high-altitude conditions by a tiny steam generator without costly furnaces, boilers, and accumulators.

It is being operated by Jet Propulsion Laboratory to test models producing up to 50,000 lbs. of thrust in a program to develop new engine concepts—and it cost $128,500.

Chemically produced steam from the generator can now be used to operate altitude chambers for companies which have been unable to afford them in the past, says Thiokol Reaction Motors Division, manufacturer of the device. The generator may also find buyers among the well-funded because of such advantages as a 15-sec. start cycle and low lead-time for design and installation.

Among the potential customers looking at the system is the joint AEC-NASA Space Nuclear Propulsion Office. If and when Nuclear Engine Test Stand 2 is built at the Nevada Nuclear Rocket Test Station, chemically produced steam may be used to evacuate its altitude start chamber.

For the past three months Thiokol-RMD has been offering the unit as a roughing pump for laboratory vacuum chambers—probably to be used in conjunction with diffusion pumps to increase the altitude capability.

● **Peroxide broken down**—The generator—trade-named Hyprox—uses the decomposition of hydrogen peroxide to produce steam, free oxygen, and heat. Hydrogen is burned with the oxygen to produce more steam and more heat. Stored water is mixed into the ultra-hot flow to increase volume of steam and reduce its temperature.

A waist-high Hyprox unit can match the output of a 150,000-lb.-per-hour water-tube boiler the size of a two-story house. Thiokol sales engineers claim comparable differences in plant cost and facility lead-time. The only admitted disadvantage is that chemically produced steam costs more per pound than boiler steam if fixed plant costs are ignored.

● **Highly scalable**—The steam produced by a Hyprox unit is uncontaminated by other combustion products. This is desirable because it insures uniform properties in the drive medium—and because engineers have plenty of experience in working with water in its various phases. Since gaseous hydrogen is used the fuels are storable and there is no possibility of explosive gels forming in the injector.

The scalability of the system seems unlimited to Thiokol engineers, and additional stages can be installed to pull a higher vacuum.

In an engine test facility, the engine itself, mounted inside a diffuser, functions as an additional stage after ignition. In some installations, the engine chamber is sealed by a big inflated rubberized ball to permit the chamber to be brought to a pressure equivalent to 300,000 ft. Engine ignition pops the ball and spits it through the ejector.

The 15-sec. start cycle for a Hyprox generator compares with an 8-hr. accumulator pressurization time for a 150,000-lb.-per-hour water-tube boiler.

The Hyprox start cycle begins with a brief pre-heat of the catalyst bed by the injection of a small amount of peroxide to improve the efficiency of decomposition when the full flow of peroxide begins. The temperature of the decomposition products is 1380°F. At this temperature, hydrogen fed into the stream through a pre-heat coil in its center ignites spontaneously. The hydrogen flow is built up gradually to insure a smooth start and combustion stability. The product of this combustion is nearly pure steam at a temperature of about 4500°F and 300 psi.

There is no problem with boiler scale, because the stored water is evaporated in the jet of high-velocity steam and shot out of the ejector. The stored water makes up about 70% of the volume of steam generated.

At the end of each run all systems are purged with nitrogen to prevent boiler scale from forming as the generator cools and to keep the fuel mixture at the controlled ratio for the next start. The unit is designed with a number of fail-safe features. An automatic shutdown can be completed in 0.5 sec.

● **In-company use**—The JPL 115,000-ft.-altitude installation at Edwards AFB is the first to be sold to a user outside the Thiokol Corp., but another is in use at the company's Elkton, Md., facility and a third has been operating at Thiokol-RMD's own High-Altitude Test Facility. The system has been field-tested for three years. ■

EOS Research To Better Ion Engines

Company program sponsored by Air Force and NASA centers on improving spacing of pores in ionizer buttons

by John F. Judge

A PAIR of refractory metal fabrication techniques and the adaptation of an ion microscope to surface ionization problems may lead to significant increases in the efficiency of ion engines at Electro-Optical Systems, Inc.

Researchers at the Pasadena, Calif., firm are perfecting approaches involving refractory wire bundles and sintered spherical powder in the manufacture of porous ionizers for electrical engines. This work may produce improved high-temperature and electrical materials for electron tubes, ablative structures and certain gas- and liquid-filtering devices.

The EOS ion engines use an array of small porous tungsten buttons to strip electrons from the cesium field. The resultant ions are accelerated by an electrostatic field to provide thrust.

EOS research into materials and fabricating methods for ionizer devices is sponsored by the Air Force Aeronautical Systems Division of the Air Force Systems Command, and by the Lewis Research Center of NASA.

● **Button approaches**—In one method, extremely fine tungsten wires are bundled together and sintered to produce a structure in which the interstices between wires serve as small-diameter openings. In the second approach, micro-spherical tungsten powders are pressed and sintered to produce a porous tungsten disc of uniform permeability characteristics.

Both methods are designed to bring individual microparticles of tungsten into a proper juxtaposition to provide ideal pore spacing for efficient and rapid ionization of cesium.

Ionizer technology requires a high degree of surface uniformity and gas-flow permeability to make possible an even distribution of the cesium vapor flow through the porous tungsten buttons.

The route to optimum ionizer performance, says EOS, is through a significant reduction of operating temperatures—hence longer life and higher reliability, a higher percentage of cesium vapor ionization, and a more evenly distributed flow of cesium vapor over the ionizer surface than presently is realized.

EOS experts believe the key to this is uniform distribution and size of pores in the tungsten ionizer buttons. Theoretically perfect spacing of such pores would be 2-4 microns apart with 0.5-1.0-micron-dia. holes. Commercially available porous tungsten measures 1-10 microns apart with diameters of 2-30 microns.

The modular construction technique developed by EOS has resulted in surfaces with pore spacing of 2-4 microns and pore diameters of 0.3-0.5 microns—and the firm expects to approximate the desired theoretical parameters with this technique. Performance tests on surfaces developed have indicated extremely low neutral fractions at high unit current densities. Principal success thus far with the tungsten bundles has been with wires 6 microns in diameter and bundled to total diameters of 3/16 in.

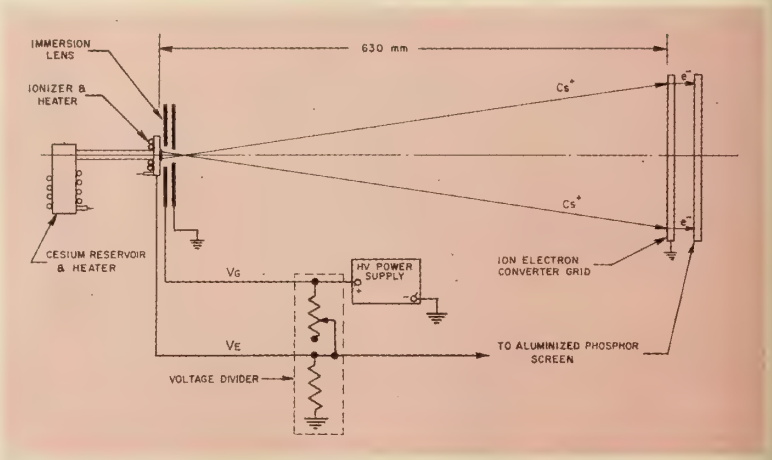
Bundled tungsten wire ionizers have produced neutral ion effluxes of less than 1% at 20 milliamp cm^{-2}. This compares to commercially available devices producing 2-3% efflux at 10-15 milliamp cm^{-2}.

Wire bundle ionizers are fabricated by winding fine tungsten wire around a mandrel. When it is tightly wound, the bundle is cut and straightened. Next, a tube is placed around the wire bundle and tightly swaged about the wire. Then the bundle is infiltrated with copper, and the tube is ground away from the bundle leaving the copper-encased tungsten wires.

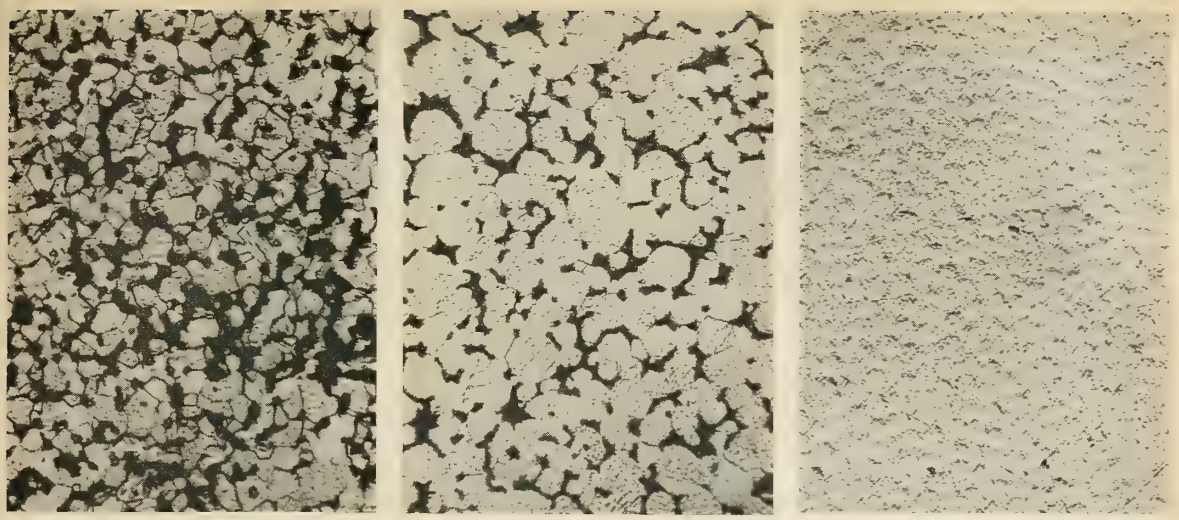
The encased tungsten wires are then removed in 1-mm-thick slices and placed in a vacuum furnace. There the copper is evaporated, and the tungsten wires are sintered together to form a porous surface.

At present, EOS is experimenting with two configurations of tungsten buttons produced in this manner for eventual use in multi-button ionizer units. One button has a round surface, and the other is hexagonal. The hexagonal button has a definite advantage in scaling up to larger multi-button ionizer arrays, EOS reports.

● **Stumbling blocks**—Several material problems were encountered in the wire-bundle approach. The first involved uniform packing of the wire to produce



IN OPERATION, cesium ions formed on ionizer surface of ion microscope are accelerated through the electrostatic immersion lens. Lens field focuses ions into a sharp image of their place of origin on front of converter grid. Here, impacting ions are exchanged for the secondary electrons used to generate a visible image on the phosphor screen. Resultant image is a true picture of surface ionization taking place at the ionizer. Apparatus is operated in a 10^{-6} torr vacuum.



PHOTOMICROGRAPHS illustrate uniformity in pore spacing achieved by the two new EOS button techniques as compared with units made from commercial tungsten powder. The commercial porous button is at the left, a spherical tungsten powdered button is at the center, and the wire-bundle approach is illustrated at the right.

uniform spacing between holes. Especially developed, careful winding techniques and the use of high swaging pressures alleviated this.

Another difficulty—obtaining tungsten wire less than 12 microns in diameter—was resolved by chemical etching to desired sizes. The usual problems associated with the mechanical handling of small-diameter wires were solved by micro-manipulation production techniques.

The second means of producing porous surfaces at Electro-Optical Systems utilizes microscopic particles of spherical powder. Tungsten discs are manufactured by pressing, sintering, and machining to shape.

The result is a surface with pores of uniform size and spacing. Tests of these units also have yielded high unit current densities with low neutral fraction similar to results from the wire bundles.

The shape of the particles adds greatly to the longevity of the units as a result of the high temperature stability associated with the low surface energy of the powders—a characteristic that also provides an excellent electrical contact. In the past, when current was broken, arcing would wear away the protruding edges of meterials produced from angular powders.

The uniform permeability characteristics and low internal surface energy of porous materials produced from the spherical powders offer promise for nozzle and other high-temperature applications, where transpiration cooling can be useful, EOS believes.

Spherical powder parts may be infiltrated readily with ceramics or metals to handle such environments.

● **Dynamic analysis**—A surface ionization microscope is being developed at EOS as a major tool for the study of cesium ionization on porous refractory metal structures. The microscope consists of an ionizer-cesium reservoir unit, an electro-static immersion lens, an ion-electron image converter, and a phosphor screen. The ionizer can be heated to 1400°C. The cesium reservoir has a separate heater and thermocouple probe.

The ionizer surface forms the first element of a three-element electrostatic immersion lens. The second and third elements are part of a fixture that can be moved along the optical axis of the system. By adjusting the positions and the voltage ratios of the elements, magnifications of the ionizer from 25 to 200 times are obtained. Since the first aperture limits the field of view, a traversing mechanism is employed to move the ionizer—permitting scanning over the ionizer surface. These adjustments can be made during microscope operation.

The ion-electron converter is used because of the short life and extremely low light intensity that phosphors have when bombarded by cesium ions. With the converter, light intensities are achieved which make images readily visible. The converter is an electroformed nickel screen, held at ground potential. It is placed in front of an aluminized phosphor which is maintained at +10 kv. Ions incident on the nickel screen produce secondary electrons, which are pulled through the open areas and accelerated into the phosphor by the electrostatic field.

Most of the work to date has centered around successful operation of the microscope. Wire bundle ionizers have been used extensively because the wires themselves provide a scale for the determination of magnification and resolution, EOS scientists report.

In addition, the bundles have sufficient non-uniformity to make recognition of certain areas relatively easy. Once an ion image area has been matched with a photomicrograph, it is possible to further identify individual wires and groups.

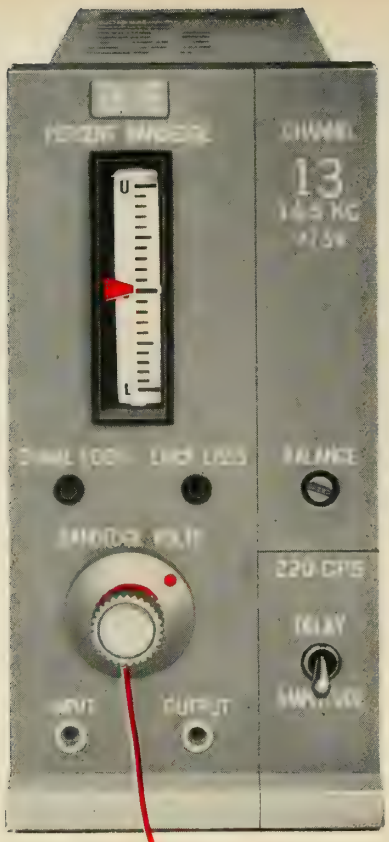
Initial results and some conclusions were presented by A. B. Marchant, G. Kuskevics and A. T. Forrest, all of EOS, at a recent American Institute of Aeronautics and Astronautics Electric Propulsion Conference.

In a 12-micron tungsten wire bundle ionizer operated below 950°C, emission is primarily from the wire ends, and some seem to emit better than others. In operation above 950°C, emission is primarily from between the wires, with some from the wire ends. The ion image intensity just below critical was about half the intensity above critical —and, at 950°C, three conditions can exist simultaneously.

With commercial sintered-tungsten-powder ionizers, large variations in surface ionization are evident.

Though EOS experts acknowledge a lack of detailed understanding of the phenomena observed in the ion microscopy experiments, benefits do accrue from the observations. For instance, it is immediately clear that great improvements in performance may be available through the production of finer and more uniform ionizer material. This was previously surmised, but the ion work lends force to the prior ideas.

Improvements in ionizer materials might be facilitated through studies into the basic phenomena, and analyses underway at EOS are expected to lead to a much better understanding of the occurrences at the ionizer surfaces. ■



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Autonetics Ready for Some New Work

Long handicapped by current work and expansion load, biggest NAA division has reorganized to compete more strongly

by Willard E. Wilks

DOWNEY, CALIF.—The Autonetics Division of North American Aviation is now driving for big new business after a frustrating period of more than two years in which it was so loaded with existing work and expansion efforts that it was unable to bid on any new major projects.

In four years, the organization grew spectacularly from 5400 to 34,500 employees—largest division of North American—and became one of the top 10 electronics companies in the country. Its sales last year were $572,810,000.

Despite all this, Autonetics President John R. Moore told MISSILES AND ROCKETS recently, the gap in new business places the division in danger of "coming to the end of our present programs in a few years with nothing to take their place."

"We were missing several bids a month. We started out working with Boeing on *Dyna-Soar (X-20)* primary guidance and flight control, but didn't pick up the bid because we didn't think we could support it with proper effort. We didn't bid on *Saint* or *Skybolt* and a whole host of things because we couldn't get the people, due to acceleration of programs we were committed to."

In addition, according to outside sources, one of the division's major customers "quietly" served notice it could expect no new business until its main effort was freed from *Minuteman* (about half its business), *Polaris* and *Hound Dog*.

"Our major customer is now aware that we are able to take on new work," Moore said.

● **Something old**—Autonetics' prime effort still is committed to "old" programs, and the division believes some growth is possible in at least two of them, as a result of recent *Polaris* and *Skybolt* developments.

Hound Dog hardware delivery (autonavigators, flight control and GSE) is almost completed, but there is speculation that some follow-on, even an improved *Hound Dog*, could result from *Skybolt's demise*. More business also could develop on *Polaris* submarine inertial navigation systems (SINS), depending upon recent agreements with the British.



MOORE—*Ready to move forward.*

Minuteman business (inertial guidance, flight control, automatic checkout, training contracts and some depot test equipment) includes considerable remaining production of basic *Minuteman*, with advanced *Minuteman* to follow.

● **Something new**—However, some reorganizations in the past few months have placed Autonetics on major competitive footing again, and, Moore promises, "we'll be in there scurrying on any new major competitions." Strongest evidence of this, he points out, are recent moves creating two executive vice presidents—Drs. Norman F. Parker and S. F. Eyestone—and a new Systems Division.

With an executive vice president for administration (Parker) and another for operations (Eyestone), the number of people reporting directly to Moore has been cut in half and he can concentrate more attention on what he calls "futures and external interface." These are being given much more attention than in the past "for new business and to insure the future," he said.

Before addition of a second executive VP, Moore oversaw operations and production, among other things, during a boom growth period in which Autonetics nearly doubled its employment, management and facilities each year.

Now, Moore says, "management can devote its time to management instead of fire-fighting. We find it advisable to be two-deep in every high-level management spot, although this goes against the management courses. One man can't do it all." In many cases, this means an "inside" man to handle in-plant duties, while his "outside" brother takes care of externals.

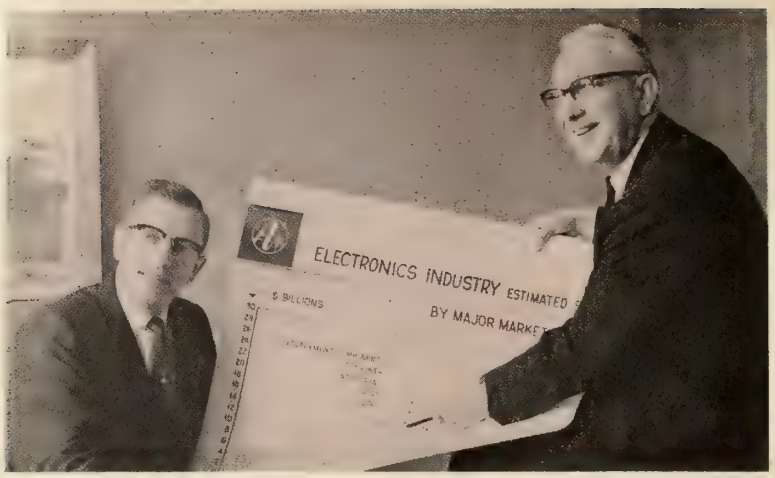
● **Better-received proposals**—The new Systems division, like the *Minuteman* division, is a management, not a manufacturing organization, and has assembled a cadre of technical and management resources on a broader base than normally required in a single product division.

While looking for its first contract, the new division is studying the possibilities of major systems which cut across the spectrum of Autonetics' product divisions—Inertial Navigation, Armament Control, Computers and Data Systems, Industrial Products. It is shooting for such programs as avionics for VAX and anything of importance in command and control, ASW and undersea exploration.

"Our plan is to consolidate and improve profit in the immediate years ahead while establishing an R&D base to move forward into new fields and improve the fields that have been responsible for our present large size and complexity," Moore said.

Since accomplishing the management changes, Autonetics is finding more welcome for unsolicited proposals than it did a year and a half ago, and is being asked for more proposals.

The North American division has picked up a number of new study contracts recently, an essential step in the process of rebuilding toward major new contracts. The new studies cover sonar



EXECUTIVE Vice President Parker (left) and VP-Long-Range Planning Bowman.

signal processing, use of certain rare metals for semiconductors, automatic landing systems, lasers and classified work in such fields as inertial guidance, advanced radars and low-altitude flight. It also has held discussions with the military and NASA which could lead to new work in command and control, advanced computer technology, automatic checkout equipment and space guidance. "Previously we didn't have enough people free to make a determined study of needs and then try to fill those needs, even for study contracts," an executive said.

● **Two categories**—As a firm largely interested in electronics and related electromechanical systems, Autonetics directs its R&D effort toward developments in things of use in equipment three to five years hence, according to Dr. Robert N. Ashby, vice president for R&D. Research is organized within seven areas of technology, including advanced systems, materials sciences, physical research, solid-state functional electronics, armament control, computers and data systems, and inertial navigation.

In advanced systems, the several space system studies under way include guidance and control for a lunar logistics vehicle, rendezvous trajectories and interplanetary missions, with consideration of soft-landing operations for Venus, Mars and the Martian satellites.

Oceanography is another prime effort in advanced systems. Autonetics is working with NAA's Los Angeles division on testing of devices, materials and shapes for the hull of a deep-diving exploration vehicle. Instrumentation devices such as cameras and sonar transducers for deep diving vessels also are under investigation.

In the field of inertial instruments, work is in progress on an electrostatic accelerometer, an electrostatic gyro, and a vibrating string gyro. Future inertial navigation systems might employ a coordinate system other than latitude and longitude.

Cedric O'Donnell, assistant director for R&D, breaks activity into two types —that which would yield a piece of hardware in three to five years, and longer-term work. About 70% of Autonetics' research budget is spent in those areas being researched by the product divisions themselves.

In its quest for new business, Autonetics now has about 300 individual sales efforts in force, more than elsewhere in NAA, according to William F. Hafstrom, vice president-marketing. "We have a more full-blown marketing organization here," he said. He sees these trends:

—Movement toward having manufacturers provide support of their own equipment "because you can't get a high-level technical education in the men recruited by the services and because equipment is getting more complicated. Automatic checkout is a fundamental part of a system, going hand-in-hand with reliability, and manual checkout damages a system."

—More complex systems presenting more complex management aspects. More interplay between subsystems, such as self-testing.

—More use from data by "completely computing it."

● **Across the sea**—Autonetics is regarded as the NAA division with the most to sell to the European market. In the company's Geneva office it maintains a staff of seven for Autonetics promotion vs. one man for other divisions.

Robert T. Jones, vice president-International Operations, said the division has a staff of 30 constantly studying defense budgets of foreign nations, with teams going abroad every six or eight weeks to make presentations. Autonetics' study of "worthwhile" overseas potential lists a market of more than $17.49 billion as of 1962, with a growth rate about twice that of the U.S.

Narrowing the European field down to electronics, Autonetics figures show a $2.5-billion market, growing to more than $3 billion by 1966. Autonetics has a group attempting to work out contracts to fit the special nature of overseas markets.

"It is a whole new concept to Europeans to go into production while still in development," Jones said. "They are used to buying from us after the bugs are out. They are insisting on straight fixed-price bids, which means a tremendous risk."

Autonetics plans to capitalize on a running start it got in Europe as supplier of the F-104G fire control system. This led to establishment of a maintenance and repair depot at Turin, Italy, and licensing agreements in Britain, Italy, The Netherlands, West Germany and Japan.

● **Research wedded to planning**—Long-range planning in the division is unique in that the entire organization is integrated into planning fuctions, according to Dr. Dean O. Bowman, vice president-long-range planning. Personnel who carry out the plans actually participate in the planning.

"This is surprising to people because most long-range planners are in the ivory tower," says Bowman. "We are unique in the sense that there is a real endeavor to tie long-range planning with the R&D program. R&D is in that way tied into business planning as well as into technical development."

The division's future plans include strong emphasis on adaptability, flexibility, resiliency. "I suspect we are entering a very difficult period," Bowman said. "The picture for big systems in the future doesn't look promising. We have to organize more to handle smaller programs. The state of the art is moving so fast that management has to be very careful. It is a difficult period of competition."

As for the outlook for new business in general, Moore notes the trend toward fewer large programs, "not only fewer big programs, but fewer pieces of equipment, smaller numbers of more complex products." But he sees various potentials with which he hopes to keep Autonetics on top.

"There is a very large potential for us in command and control. We have the heart of it with our data systems. We're going more and more to micro-electronics, and with them to design of more complicated systems. The heart of almost any of these systems is becoming the digital computer, and we're going to digital computers to perform more tasks. One of the most exciting fields of the future is self-organizing bionic machines. Their potential is nearly unlimited." ■

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In-Line Vacuum Ups Thin Film Output

Western Electric discloses new technique for turning out tantalum-deposited substrates

by Michael Getler

PRINCETON, N.J.—Economical large-scale production of integrated vacuum-deposited thin-film passive circuits is nearer reality, as a result of work done at Western Electric Co.'s Engineering Research Center here.

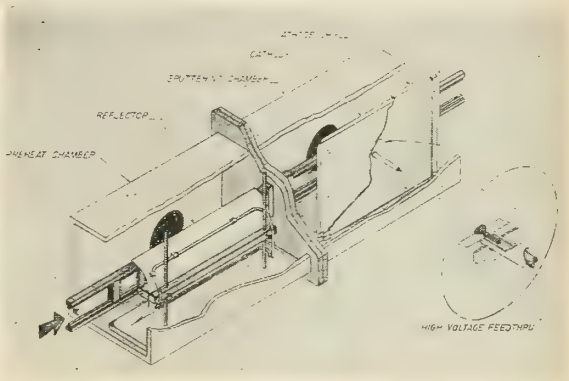
The effort is aimed primarily at meeting circuit requirements for the Bell System's vast electronic switching network. However, engineers speculate that as reliability data on thin-film circuit performance accumulates, and as thin-film technology expands into wider circuit capabilities—particularly using active devices—methods used here could supply these extremely small and lightweight circuits for large-quantity missile and space systems. Bell Laboratories is said to be receiving production rate and reliability inputs for design consideration in some advanced systems.

Key to the system is an in-line, multi-chamber, continuously-operating vacuum machine, with sensitive associated control hardware, in which a thin tantalum film is deposited on glass or ceramic substrates. Finished circuits are processed after the tantalum deposition by using standard photo-etching, anodizing, and gold interconnection overlay deposition methods.

The in-line process, ERC officials believe, will replace the more traditional but far slower bell-jar batch processing of thin films. The jar-type process, the firm reports, is an inherent cost and reliability disadvantage for large-scale production because of long pump-down and jar-preparation times and lack of film uniformity and reproducibility from different jars—and even from cycle to cycle within the same jar.

Engineers here say their experimental machine can deposit 50 sq. in. of tantalum film per minute, equal to about 75 individual circuits. Reliability data reportedly indicate resistor circuits which can be produced will exhibit a maximum 1% change from design value after 20 years, and 0.05% after five years.

● **Use with tantalum new**—The concept of using in-line vacuum techniques for sputtering thin metal deposits on large numbers of components is not new (Western Electric's North Carolina Works has been using this method to deposit gold ends on carbon resistors for about two years, supplying much of the basic work for the ERC design); but its use with tantalum under the difficult control parameters required for high-reliability resistor and capacitor circuits is considered as an important advance.



SKETCH of portion of vacuum machine shows pre-heat and sputtering chambers where substrates are prepared for, then coated with, a 1000-Ang. tantalum film.

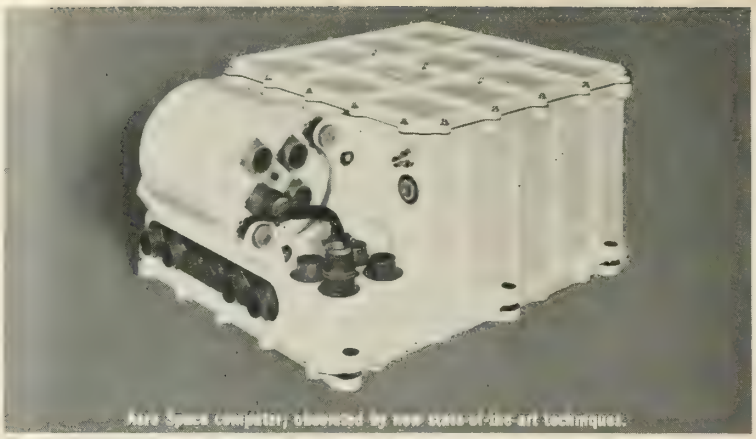
The ERC set-up is an open-end system in which a small amount of outside atmosphere actually enters the interconnected vacuum machine modules (there are 11 chambers in the experimental model) from both terminals. The amount of air that enters the ends of the system is determined by the minimum mechanical clearance required by the conveyor system which transports the substrates through the vacuum machine. Standard backing pumps, diffusion pumps, and mechanical booster pumps are used to maintain various evacuation levels in the chambers. The entire machine, ERC reports, reaches operating pressures within ten minutes after start-up.

The in-line deposition process begins and ends in an adjacent clean room. Initially, an operator loads the 2x3-in. wafers into a rail-mounted carrier which transports the substrates through the vacuum deposition and subsequent cooling process, then returns it through an enclosed and controlled-atmosphere container to the same room. Here, it is removed for circuit etching, and another basic unheated substrate is loaded.

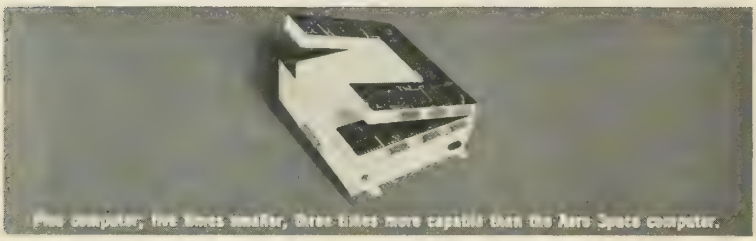
● **Vacuum levels**—Air entering the first chambers at opposite ends is pumped down to 3.5 torr. Air reaching the second set of chambers is further reduced to $3x10^{-3}$ torr. The maximum system vacuum of 10^{-6} torr is attained in the third and fourth sets of chambers, which are raised to even higher temperatures and vacuums than the sputtering chamber in order to bake out the adsorbed gases and vaporize remaining surface contaminants. This minimizes chances of any further desorption during the film deposition. These pre-sputtering chambers are fitted with infrared-focused pre-heaters for out-gassing and raising the substrate temperature.

In the sputtering chamber, high-purity argon is ionized in a glow discharge, with the argon atoms dislocating metal atoms from the tantalum cathode. These tantalum atoms coat the substrate with a 1000-Ang.-thick film. To keep the gas density low (a pressure of 30 microns is used) and reduce resistance in the paths of the tantalum atoms, 5000 volts is delivered to the cathode through specially designed feedthroughs.

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resistive films are formed by introducing small amounts of nitrogen into the argon-glow discharge, under stringent controls. The nitrogen combines with some of the reactive tantalum atoms to form these films, which, BTL reports, have shown resistance changes of less than 0.07% per thousand hours of load life.

ERC reports normal argon flow is approximately 23 std. cc per min., and the nitrogen flow must be controlled to within ±0.03 std. cc per min. Engineers claim development of a system to control and read gas flow rates to ±0.01 std. cc per min.

Other tight production control demands must be met by this system to turn out consistently high-reliability circuits (the 1000-Ang. films must be uniformly deposited to within ±50 Ang.); and, to maintain purity in the sputtering chamber atmosphere, impurities from the air and from the glass substrate must be less than 50 parts per million to the gas in the chamber.

● **Tantalum advantages**—Three major reasons were cited by ERC engineers for choice of tantalum as the thin-film material. Since tantalum can be anodized, the top layers can be oxidized under controlled electro-chemical conditions. These oxide layers form an extremely tight bond to the metal, giving to the film excellent protection against abrasion or corrosion.

The controlled oxidation, they point out, can also be used to change the thickness of the film, allowing adjustment of resistance values after deposition. For example, they said, 400-ohm resistors can be changed to 2400 ohms, and properly zigzagged resistors can be adjusted to values of millions of ohms.

In addition, this oxide film can be used as the dielectric of a high-value capacitor. The tantalum, they explain, is anodized to form tantalum pentoxide. Another electrode of gold is then deposited on top, completing formation of the capacitor on the film.

Thus, using a gold or similar metal overlay to improve conductivity in the internal interconnection paths, passive integrated circuits of resistors and capacitors can be formed using the single material.

Western Electric officials said the device at Princeton would remain an experimental system, aimed at collecting tremendous amounts of reliability data required on inherently long-life circuits, and at refining the process. Production devices will soon be put into operation.

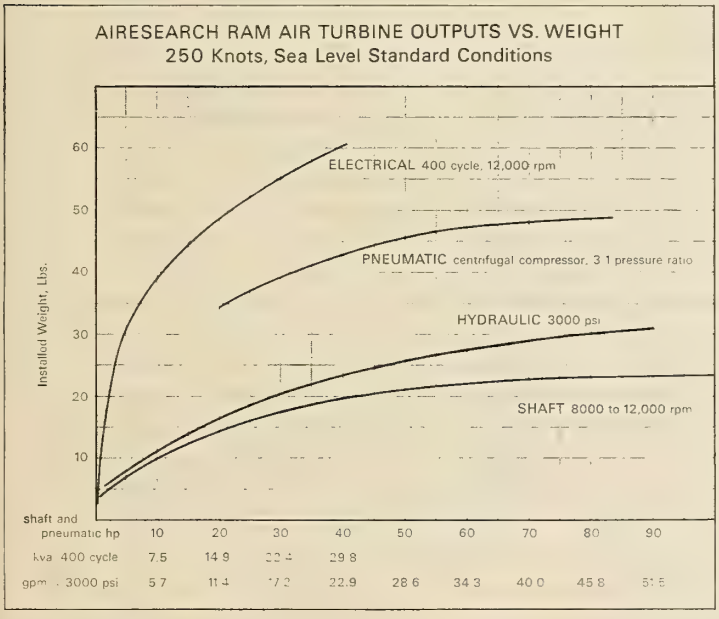
One ERC officer said: "We are looking forward to making millions of tantalum thin-film circuits, starting this year." With the in-line vacuum development, an ERC engineer stressed, "a whole group of new circuits is economically possible." ■

Lightweight, independent power systems

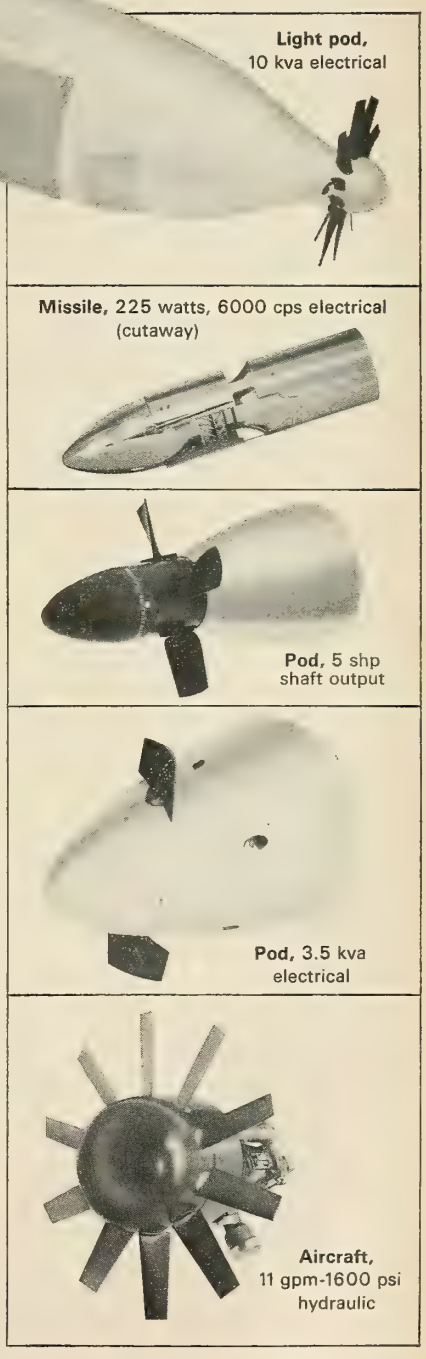
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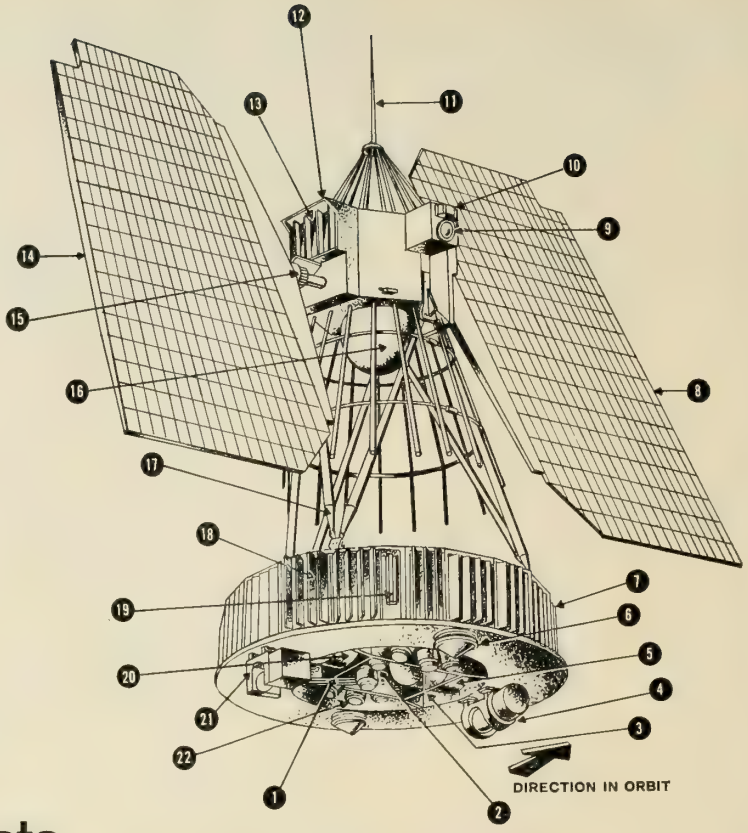
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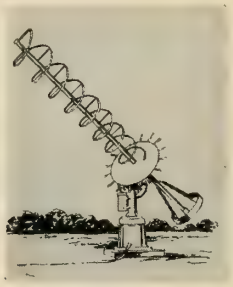
An ingenious Automatic Picture Transmission Subsystem (APTS) will be aboard the first NIMBUS satellite ... to be launched late this year.

NIMBUS' polar orbit will place the satellite over every spot on Earth at approximately noon, local time, each day. APTS—one of four meteorological information gathering systems included in NIMBUS—will permit meteorologists of all nations to obtain local area cloud pictures with inexpensive ground equipment. Usable immediately for weather analysis and forecasting, the pictures will encompass a 1,000,000-square-mile area and will be transmitted continuously as a "narrow-band" TV signal at 136 mc. They will be reproduced, line by line, on a specially adapted facsimile machine. The only other ground equipments needed are a helical antenna, pedestal, and preamplifier (see small picture) and the receiver feeding the facsimile machine. Total cost for a complete ground station will be $30-40,000.

More accurate weather analyses and forecasts are of inestimable value to the economies and people of every nation ... a leading technical journal has predicted that success of the APTS experiments alone "will probably bring more daily benefits to more people than any other project in the world's space program." The U.S. Weather Bureau is cooperating with NASA in the NIMBUS program, for which NASA's Goddard Space Flight Center is prime contractor.

ENGINEERS AND SCIENTISTS: Join NASA now, and participate on projects with the scope and significance of NIMBUS, APOLLO (manned lunar landing), GEMINI, and all the other manned and unmanned NASA programs. Applicants must have a BS or advanced degree from an accredited college or university. Send your resume to the Personnel Director, Dept. NA-3, of:

NASA Goddard Space Flight Center, Greenbelt, Md. (suburb of Washington, D.C.); NASA Marshall Space Flight Center, Huntsville, Ala.; NASA Manned Spacecraft Center, Houston, Texas; NASA Lewis Research Center, Cleveland, Ohio; NASA Launch Operations Center, Cape Canaveral, Fla.



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NASA

The Industry Week

Mergers and Acquisitions

Aero-Chatillon Corp., Burlington, N.J., manufacturer of precision machine components and electro-mechanical assemblies for missiles, space vehicles, and nuclear energy installations, has acquired the Curran Machine Works, Inc., of Long Island City, N.Y. Curran machines missile gearboxes, gyroscopes, and potentiometer housings. . . . *Dynamics Corp. of America, producer of aerospace systems and equipment, has purchased International Electronic Research Corp. of Burbank, Calif. IERC produces heat dissipating and retaining devices for tubes and transistors in electronic systems.* . . . Electronic Speciality Co., Los Angeles, has acquired H&S Metal Products Co., supplier of aerospace mechanical components. H&S will continue operation in Los Angeles as a division of Electronic Specialty Co. . . . *Control Data Corp., Minneapolis, has acquired the Bendix Computer Division as part of CDC's effort to broaden market areas and product lines.* . . . Baldwin-Lima-Hamilton Corp. has joined Carl Schenck Maschinenfabrik, G.m.b.H., of Darmstadt, Germany, in the formation of a jointly owned affiliate, Hottinger-Baldwin Messtechnik, G.m.b.H. The new company will be located in Darmstadt, and will manufacture all of the strain gages and force measurement equipment made by the BLH Electronics Div. in Waltham, Mass. The arrangement aims at giving BLH a strong position in the Common Market missile/space electronics industry. . . . *Greer Hydraulics, Inc., Los Angeles, has announced formation of an Aerospace Systems division. The new division will concentrate on military research and development projects in the area of fluid systems.*

Industry Facilities

Vacco Valve Co., El Monte, Calif., aerospace component manufacturer, has completed a new $250,000, 40,000-sq.-ft. plant. The new facility will permit independent functioning of the company's valve and filter divisions. . . . *Documentation Incorporated has opened a $1.4-million headquarters in Bethesda, Md. The 107-ft.-tall structure provides 43,000 sq. ft. of new space, and is expandable to 65,000 sq. ft. to meet future needs.* . . . Dow Corning Corp. plans a multimillion-dollar expansion of silicon-manufacturing facilities in Midland and Hemlock, Mich. and in Elizabethtown, Ky. . . . *Control Data Corp.'s Albuquerque sales office has moved to new quarters at Marberry Plaza, 5905 Marble Ave., N.E. The new office will house the sales and service staff responsible for CD marketing in a large part of New Mexico.* . . . The Hallicrafters Co., Chicago electronics firm, has purchased 17 acres near Wilton, Conn. as a new facility site for its subsidiary, Mason Laboratories, Inc. Mason specializes in the research, development, and production of military communications, and high-power equipment.

New Firms and Divisions

LP Associates, Inc., has been formed in Los Angeles to offer specialized equipment and engineering services in the fields of parametric amplifiers, solid-state frequency multipliers, ferrite microwave devices, microwave antennas, pulse modulators, and linear accelerator components. . . . *Aerosystems Technology Corp., formerly of Sparta, N. J., has transfered its corporate headquarters to Wayne, N.J., and established a new consulting division in New York City. The new division, located in the Empire State Building, is called Product-Personnel-Facility Consultants. PPFC was created to advise potential investors in scientific and technical companies.* . . . American Machine and Foundry Co., New York City, has formed AMF Industrial Products Group consisting of three of the company's subsidiaries: AMF Beaird, Inc., Shreveport, La.; Thermatool Corp., New Rochelle, N.Y.; and American Iron & Machine Works Co., Inc., Oklahoma City. . . . *The Bendix Corp, Detroit, has formed a new organization to conduct overseas sales and activities with foreign affiliates and licensees. Bendix International Operations will have executive offices in New York City.* . . . The General Electric Co.'s Technical Military Planning Operation (TEMPO) at Santa Barbara, Calif., plans to expand activities to provide advanced planning services to the company's Aerospace and Defense Group. GE's Defense Programs Operation, to which TEMPO now is directly assigned, provides a focal point for customers of the products, services and systems of G-E aerospace and defense departments.

Representatives Named

Technical Representation, Inc., Englewood, N.J., has been appointed sales representative for northern New Jersey and southern New York by the electronics div. of Baldwin-Lima-Hamilton Corp., Waltham, Mass. BLH's Electronics Div. manufactures strain gages; transducers for measuring and controlling force, pressure, and torque; temperature sensors; signal-conditioning equipment; and instruments and systems for military, industrial, and commercial uses. . . . *Astro Associates, Houston, has been appointed local representative for Metric Systems Corp. of Ft. Walton Beach, Fla. Metric Systems specializes in missile range and satellite tracking instrumentation, including complete radar systems, infrared tracking instrumentation, precision timing systems, and digital data acquisition and reduction systems.* . . . Hytronic Measurements, Inc., Denver, has been named technical representative for Phelps Dodge Electronics Products Corp. for Wyoming, Utah, Colorado, New Mexico, and El Paso County, Texas. PDE's line includes air dielectric semi-flexible coaxial cable, connectors, cable delay lines, and custom waveguides. . . .



SYSTEMS MEN: CONTACT MITRE

Because of the increasing need for more advanced defense systems, MITRE is expanding its technical staff.

MITRE's prime mission:

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- To design new sensory, communications, and display systems.
- To explore every possible technique that might give the military commander extra seconds for decision and action.

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- Operations Research
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- Radar Systems and Techniques
- Air Traffic Control
- Space Surveillance
- Space Systems Command and Control
- Astrodynamics

Minimum requirements, B.S., or M.S., or Ph.D. in these disciplines: electronics, physics, and mathematics. MITRE is located in pleasant, suburban Boston. Rewards are competitive. Write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, P.O. Box 208G, Bedford, Massachusetts.

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Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.

contracts

AIR FORCE

$16,000,000—**Minneapolis-Honeywell Regulator Co.'s Florida Aeronautical Div.,** St. Petersburg, for additional work on the *X-20 (Dyna-Soar)* space vehicle guidance system.

$8,000,000—**Systems Development Corp.,** Santa Monica, Calif. for development of electronic system training programs.

$6,500,000—**Boeing Co.,** Seattle, for engineering and development on improved *Minuteman* missiles.

$5,100,000—**Martin Marietta Corp.,** Baltimore, for research on the manned launch vehicle under the *Gemini* program.

$3,893,000—**Martin Marietta Corp.,** New York City, for installation and checkout of *Titan I* missile facilities. Work to be done at Ellsworth AFB, S.D.; Larson AFB, Wash.; Mountain Home AFB, Idaho, and Beale AFB, Calif.

$2,975,000—**General Dynamics Corp.,** New York City, for manufacture and delivery of *Atlas* missiles. Work to be done at San Diego, Calif.

$2,500,000—**General Precision, Inc.,** Little Falls, N.J.; for continued development of a guidance system.

$2,400,000—**Philco Corp.,** Palo Alto, Calif., for space program control subsystem work.

$2,300,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for space subsystem work.

$2,000,000—**General Dynamics Corp.,** San Diego, Calif., for *Atlas* missile technical manuals.

$1,900,000—**General Dynamics Corp.,** San Diego, Calif., for work on *Atlas* missiles.

$1,800,000—**Systems Development Corp.,** Santa Monica, Calif., for training programs.

$1,554,000—**Radio Engineering Laboratories,** Long Island City, N. Y., for provision of materials for improvement of electronic equipment used in the Distant Early Warning (DEW) Line.

$1,400,797—**American Machine and Foundry Co.,** New York City, for work on the *Titan I* launcher system. Work to be done at Ellsworth AFB, S.D.; Mountain Home AFB, Idaho; Larson AFB, Wash., and Beale AFB, Calif.

$1,313,993—**Avco Corp.,** New York City, for research and development work on re-entry vehicles.

$1,300,000—**General Motors Corp.,** Detroit, for research and development on the *Titan II* guidance system (supplemental contract). Work to be done by the AC Spark Plug Div., Milwaukee.

$1,000,000—**General Electric Co.,** New York City, for procurement of missile-borne instrumentation and range safety equipment in support of the *Titan I* and *II* and the *Gemini* programs. Work to be done at Syracuse, N. Y.

$100,000—**Lockheed Propulsion Co.,** Redlands, Calif., for 45 *Javelin I* test sled rockets.

ARMY

$1,900,000—**Martin Marietta Corp.,** Orlando, Fla., division, for modification and supply of spare parts for *Pershing* missile system (three contracts).

$1,242,000—**General Dynamics Corp.,** Pomona, Calif., division, for research and development of the *Redeye* missile system.

$752,000—**Hayes International Corp.,** Birmingham, Ala., for tooling, spare kits and parts, for the *Pershing* missile trainer.

$267,300—**Douglas Aircraft Co.,** Santa Monica, Calif., for *Nike-Hercules* launcher control group.

NAVY

$1,500,000—**North American Aviation, Inc., Rocketdyne Div.,** McGregor, Tex., for production of *Sparrow III* missile rocket motors.

$1,485,000—**Radio Corp. of America,** Moorestown, N. J., for missile precision instrumentation radar.

$1,400,000—**Sperry Rand Corp., Ford Instrument Div.,** Long Island City, N. Y., for fire control system computers.

$1,118,250—**Martin Marietta Corp.,** Orlando, Fla., division, for work on *Bullpup* missile system components.

$912,800—**Eastman Kodak Co.,** Rochester, N. Y., for *Sidewinder 1A* air-to-air missile fuzes.

$700,000—**General Dynamics Corp.,** Pomona, Calif., division, for *Tartar* and *Terrier* guidance and control.

$214,700—**Vitro Corp., of America, Vitro Laboratories division,** Silver Spring, Md., for basic guided missile launching systems design, research, development and engineering.

$129,400—**Minneapolis-Honeywell Regulator Co.,** Hopkins, Minn., for *Asroc* missile nose caps.

$72,300—**Sanders Associates, Inc.,** Nashua, N. H., for pulse Doppler seeker for terminal missile guidance.

NASA

$800,000—**William J. Graham and Son Co.,** Golden Beach, Fla., for maintenance and operation of the Manned Spacecraft Center's building, facilities, utilities and grounds.

$534,796—**Sapp Construction Co.,** Orlando, Fla., for erection of a one-story communications repeater building and installation of an electrical system on NASA's Merritt Island launch area.

$218,675—**American Machine and Foundry Co.'s Field Operations and Engineering Div.,** Santa Barbara, Calif., for fabrication, installation, cleaning and testing pneumatic and electrical distribution systems on Complex 34 at Cape Canaveral.

$119,800—**Thiokol Chemical Corp.,** Elkton, Md., for research and development on high-specific-impulse solid propellant.

$119,532—**Martin Marietta Corp.,** Denver division, for a dynamic design analysis of the *Saturn V* launcher umbilical tower.

INDUSTRY

$3,577,500—**Nortronics, Precision Products Dept.,** Norwood, Mass., from **North American Aviation, Inc.,** for auxiliary gyroscopes to be used in the *Minuteman* program.

$1,700,000—**Fischbach and Moore, Inc.,** from **United Technology Center,** for solid rocket test facility instrumentation at Edwards AFB, Calif.

$1,620,500—**Texas Instruments, Inc.,** Dallas, from **North American Aviation's Autonetics Div.,** for autocollimators for use in the *Minuteman* program.

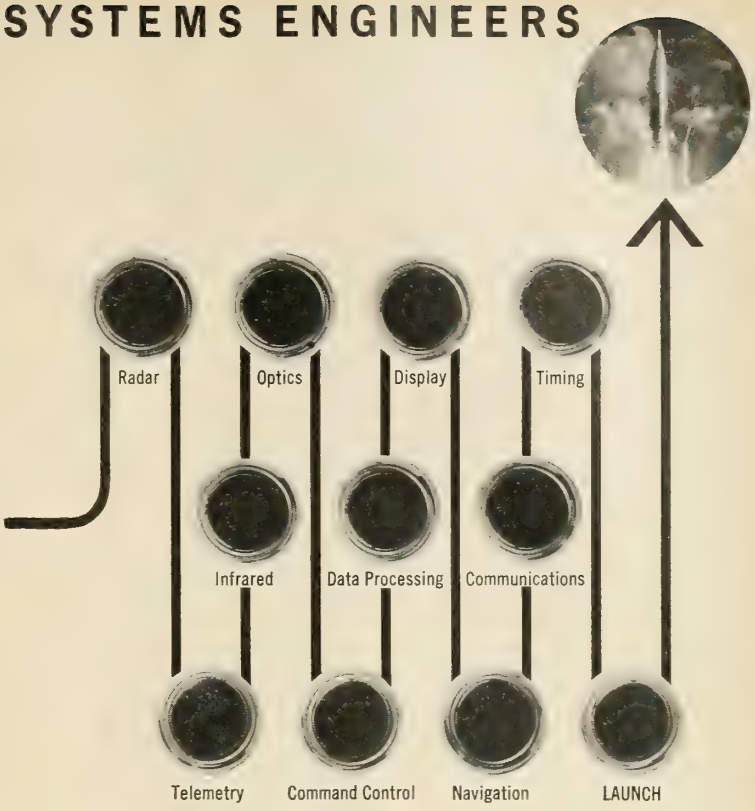
$1,400,000—**General Motors Corp., AC Spark Plug Div.,** Milwaukee, from **North American Aviation's Autonetics Div.,** for sensing units for the *Minuteman* missile.

$1,300,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, from **North American Aviation's Autonetics Div.,** for accelerometers and sensing units for *Minuteman* missiles.

$988,000—**Ling-Temco-Vought, Inc.,** Dallas, from **Chrysler Corp.,** for continued production of fuel and oxidizer containers for the first stage of NASA's *Saturn I* rocket.

$885,000—**Raytheon Co.,** Mountain View, Calif., from **Boeing Co.,** for ultra-reliable transistors for the *Minuteman* missile.

SYSTEMS ENGINEERS



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data handling, including real-time transmission and computation, post-flight data processing, and data display.

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Circle No. 12 on Subscriber Service Card

New Product of the Week:

Gallium Arsenide Emitting Diode

Infrared Industries, Inc., has available its Model 437 gallium arsenide emitting diode. Packaged in standard subminiature glass diode configuration, the unit emits in a doughnut pattern, allowing 360° collection and concentration of energy.

Peak wavelength is 0.94 microns, with a 0.04-micron bandwidth. There are three classes of Model 437—varying according to radiant power output and efficiency. Models 437a, b, and c have minimum radiant intensities at $1.0x10^{-5}$, $3.5x10^{-5}$ and $7x10^{-5}$ watts/steradian when operated at a current of 180 ma.—corresponding to an efficiency of from 0.04% to 0.35% at room temperature.

The maximum average current is 180 ma., says II, but the diodes can be pulsed with currents as high as 12 amps to give a peak output intensity of $5x10^{-3}$ watts/steradian. Cooling to 77°K is said to increase output and efficiency approximately 30 times, and to allow use of short pulses as high as 100 amps.

Circle No. 225 on Subscriber Service Card

VHF Duplexer

A solid-state VHF duplexer for use in rugged service with both CW and pulsed transmitters is available from Micro State Electronics, Corp.

The unit provides at least 33 db isolation between the transmitter and receiver terminals. The transmitter-to-antenna loss is less than 0.25 db while antenna-to-receiver loss is less than 0.2 db, developers say.

The Model D0101 covers the frequency range of 135 to 150 mc and will handle more than 70 watts CW or 4 kw at 0.01 duty cycle with up to 5 μsec pulse width. The D0101 requires no bias or keep-alive supplies, as it is RF activated.

Circle No. 226 on Subscriber Service Card

Large Tach/Torquer

Inland Motor Corp. has developed a combination tachometer-generator/torque-motor. Speed is controlled, using torques of up to 300 lb./ft., over a range of 0.1°/sec. to 180°/sec.

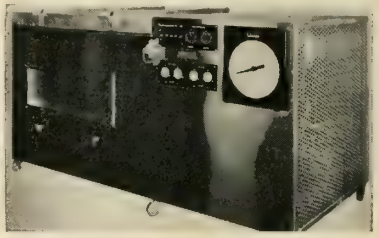
These combination tach/torquers can be produced in sizes comparable to Inland's standard torque motors, which range from 2 to 45 in. in dia.

The combination unit has an 18-in. rotor dia. and a 26⅝-in. overall dia.

Circle No. 227 on Subscriber Service Card

Environmental Chamber

Available from Webber Mfg. Co., Inc., a portable 3x3x3-ft., top-opening environmental chamber, Model AT-27-



125+600, features a 24-in.-wide viewing window and a temperature range from 600° to −125°F, shifting from ambient to either extreme in 25 minutes with 1°F accuracy throughout the entire range, Webber says.

Other features include: thermocouple-operated recorder and controller with 12-in. electronic circular chart, air-cooled refrigeration units, air-operated lid and built-in air compressor.

Circle No. 228 on Subscriber Service Card

D-C Power Supply

Hyperion Industries, Inc., has developed a 5-amp. standard d-c power supply, an all-solid-state unit which has a variable output voltage of 0-32 vdc at a load of 0-5 amps. Input voltage is 105-125 vac, 60 cps. The unit features remote sensing, remote programming, vernier voltage adjustment, current and



voltage metering, floating output, and adjustable current limiting. It is also short-circuit proof, the company says. Response time is 50 milliseconds.

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Vacuum Pumping System

A packaged vacuum pumping system is available from Consolidated Vacuum Corp. Designated PS-62, the unit has an ultimate pressure of 3.5×10^{-8} torr with a liquid-nitrogen baffle, and 2.5×10^{-7} torr with an ambient-cooled baffle. With a blank-off plate, pump-down time from atmosphere to 8×10^{-7} torr is 10 minutes, and plateau pumping speed is 400 liters per second.

The basic PS-62 package includes a 6-in. diffusion pump, a 6-in. straight-through valve, bellows valves for roughing and fore lines, and a combination ionization-thermocouple gauge. The system is flexible with 25 standard accessory options, including five baffles, six gauge combinations and five mechanical pumps.

Circle No. 230 on Subscriber Service Card

Trimmer Potentiometer

Daystrom, Inc., has available a subminiature trimmer potentiometer. Resistance range of the new Model 515 is from 10 ohm to 50K over an operating temperature range of from −55°C to 150°C. Power rating is 1 watt at 55°C. The unit is built to resist shock, vibration and fungus, Daystrom says.

Circle No. 231 on Subscriber Service Card

Analog Computation Line

Computer Systems, Inc., has developed a line of general-purpose analog computers. Named DYSTAC SS-100, the line is completely solid-state with a computing range of +100 to −100 volts.

The SS-100 includes conventional real-time in addition to the high-speed iterative mode, with which the operator can view a series of solutions—each being completed in a few thousandths of a second. The 100-volt level makes possible a dynamic range of 10,000 to 1, with accuracies of 0.01%, Computer Systems says.

Circle No. 232 on Subscriber Service Card

Zero Reference System

Developed by Dynamics Research Corp., the Optisyn incremental shaft-angle encoder, with a zero reference system, is said to bridge the gap between incremental and absolute encoders. The unit consists of a nulling device for permanent shaft-to-housing position reference, and a circuit that produces a precise zero pulse—accurate to ±0.5 count—once every shaft revolution.

The unit may be used as an alarm, to clear a counter, or to trigger a signal for automatic resetting.

Circle No. 233 on Subscriber Service Card

Solar Simulator

A solar radiation simulator developed by Genorco Inc. for NASA uses as a radiation source a high-intensity carbon lamp that operates for 24 hours without interruption. Twenty two-in.-long carbon positive electrodes are stacked in a steel magazine, fed automatically to the arc lamp and joined together to assure continuity of operation without need of an operator, Genorco says.

Circle No. 237 on Subscriber Service Card

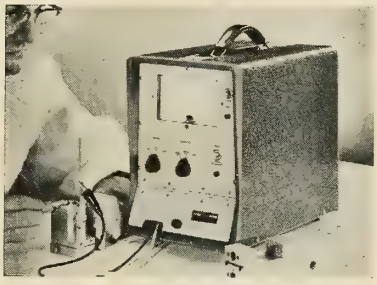
Zener Diodes

Temperature-compensated zener diodes are available from Dickson Electronics Corp. Zedec series 1N4057 through 1N4085 specifies 29 voltages between 12.4v and 200v, with a temperature coefficient of 0.005% per degree C and nominal voltage tolerances of ±5%. The suffix A (1N4057A-series) denotes a temperature coefficient of 0.002% per degree C over a temperature range of −55°C to 100°C.

Circle No. 238 on Subscriber Service Card

Voltage Breakdown Tester

A non-destructive quality control tester for d-c voltage breakdown levels in components is available from Micro-



dot Inc. The Model 1901A makes possible breakdown voltage reading without harming the test specimen.

Selector switches on the front panel determine the range (1 kv or 4 kv) and the amount of ohmic current flow (10 microamperes, 100 microamperes, or 1 milliampere).

Circle No. 239 on Subscriber Service Card

Telemetry Microbarograph

Statham Instruments, Inc., is marketing its remote telemetry microbarograph, Model S3-0. The unit is on an absolute pressure transducer having an excursion of 100 millibars, an accuracy of ±2 millibars and an electrical output of from 0 to 5 volts d-c. The device can be connected to a chart recorder; used with a visual display on a voltmeter; or connected through a ground-based telemetry link to oscillographs, computers and other data-handling equipment. The microbarograph is housed in a weather-resistant case for vertical mounting, outdoors or indoors.

Circle No. 240 on Subscriber Service Card

Iron Powder

Alan Wood Steel Co. is marketing a type of iron powder designed to yield high strength with carbon additions. AW941 is compacted to medium-high strength up to 85,000 psi with 2% elongation. After heat treatment, parts molded from powder have a tensile strength of from 95,000 to 125,000 psi at 6.4 to 6.8 g/cc density, the company reports.

Circle No. 241 on Subscriber Service Card

Camera-Recorder

Graphic Instruments, Ltd., of England is marketing a multi-channel oscillograph camera-recorder having a frequency response that ranges from d-c to 6,000 cycles per second, natural frequency.

The relatively small recorder is designed and mounted in such a way that it swings free and may be used in a great variety of environments, Graphic Instruments says.

Circle No. 242 on Subscriber Service Card

Cryogenic Thermometer

A direct-reading thermistor thermometer for cryogenic applications is available from Numec Instruments and Controls Corp.

The probe is inserted into the material to be measured—such as liquid oxygen or nitrogen—and the meter is adjusted to zero by means of a potentiometer. Temperature can be read directly in digital form from the face of the potentiometer.

The device has a range of 76-91°K, accuracy to ±0.05°K, and sensitivity of ±0.01°K, the manufacturer reports.

Circle No. 243 on Subscriber Service Card

Multipurpose Computer

The Mnemotron Div. of Technical Measurement Corp. is marketing a computer of average transients—a multipurpose computer said to be capable of detecting, isolating and measuring repetitive transient signals occurring in as finite a time segment as 78 microseconds.

The unit can perform amplitude density spectra, other amplitude and time histograms, and averaging of repetitive signals masked by noise. Results are immediately made available as an oscilloscope pattern, or with accessory such as digital or analog readout. Analysis time is 16 seconds, the firm says.

Circle No. 244 on Subscriber Service Card

Pressure Transducer

Wiancko Engineering, division of Tamar Electronics, Inc., is marketing a pressure transducer designed for static-testing of rocket engines, ground check-



out, calibration and pressure-control equipment.

The units can be energized by a common 28-volt power source, since each has input/output isolation, and both input and output are isolated from ground.

Circle No. 234 on Subscriber Service Card

Elastomeric Laminate

The Reinforced Plastics Dept. of Raybestos-Manhattan, Inc., has developed an elastomeric laminate adaptable to both cryogenic and pyrogenic applications.

R/M Style 91-RPM is an asbestos-reinforced plastic designed for insulating applications where rapid changes in temperature are anticipated. The material has physical properties that make it suitable for lining missile and rocket engine cases, developers say.

The laminate has a tensile elongation of 15%, with ablation resistance and insulating properties, which are said to be good. Specific gravity of the material ranges from 1.43 to 1.48. It has a tensile strength of 4000 psi and a modulus of elasticity in tension of 400,000 psi.

Circle No. 235 on Subscriber Service Card

Coaxial Patch Panel

Andrew Corp. has available a compact 10x10 patch panel for 3⅛-in., 50-ohm transmission line. Type 27935 features a panel layout of terminals in three concentric circles and a dummy load connection at the center of the panel. This layout allows any transmitter to be connected to any of the 10 antenna terminals or to the dummy load.

An interlock system requires positive "U"-link contact and locking before the interlock circuits are activated. The locking levers activate interlock switches and indicating circuits behind the face panel at each terminal—preventing accidental override of any interlock circuit.

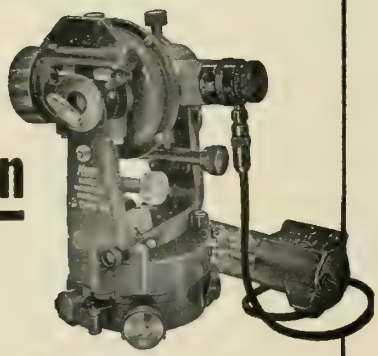
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ELECTROMANOMETERS—A two-page bulletin, describing the capabilities of CEC's rack-mounted electromanometers, is available from Consolidated Electrodynamics Corp., subsidiary of Bell & Howell. The precision pressure balances are designed to measure differential, gage, and absolute pressures to 500 psi. Seven standard full-scale ranges are available starting as low as ±1.5 psi.

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WORLD SPACE DIRECTORY COMPLETE MISSILE/SPACE REFERENCE GUIDE

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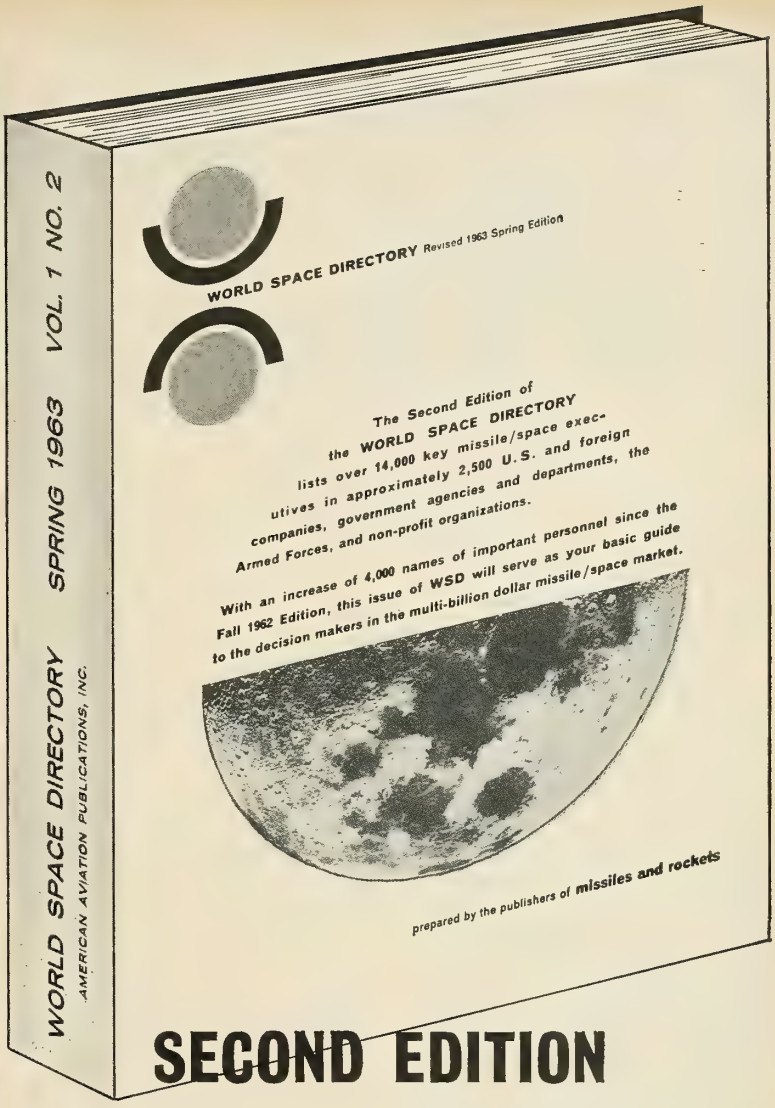
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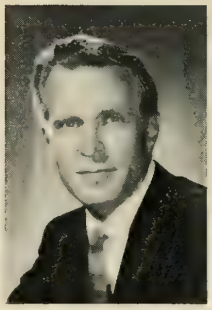
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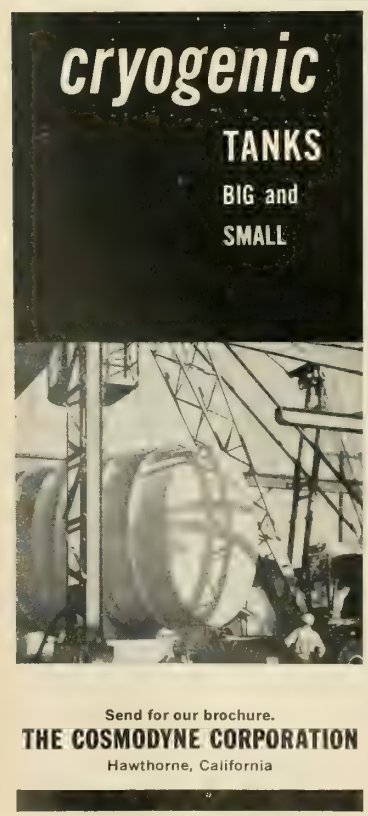
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Robert H. Matthies: Appointed manager of industrial relations at the AETRON Div. of Aerojet-General Corp., Covina, Calif. **Richard J. Ryan** named manager of product effectiveness.

Franklin C. Spinney: Appointed senior marketing representative at United Technology Center's Washington, D.C. office.

Kenneth A. Roe: Elected president of Burns and Roe, Inc., New York City.

Lee Garbowitz: Joined staff of Electro-Optical Systems, Inc., Pasadena, Calif., as manager of quality assurance. **Dr. David Medved** joined staff as manager of advanced concepts.



James W. Jones: Appointed Washington, D.C., regional manager for the Singer Metrics Div. of Singer Manufacturing Co., Bridgeport, Conn.

R. G. Johnson: Promoted to vice president-finance of the Information Systems Group of General Pecision, Inc., Tarrytown, N.Y.

Dr. D. H. Pickrell, Jr.: Appointed assistant chief engineer for current programs at Autonetics' Inertial Navigation Div., Anaheim, Calif. **W. T. Kennedy** named manager of the Inertial Instrument Engineering Dept.

Don Tonnelli: Promoted to manager-experimental manufacturing at the Fruehauf Military Products Div.-East of the Fruehauf Trailer Co., Detroit, Mich. **Joseph Ferrante** named manager-industrial engineering at the division's Delphos, Ohio, plant.

Dr. Arthur H. Benner: Formerly with Radio Corp. of America, named director of engineering-military systems at Lockheed Electronics Co., Plainfield, N.J.

Robert A. Strieby: Appointed resident manager reporting to the western regional office of Consolidated Systems Corp., Monrovia, Calif.

Dr. Gordon W. Ballmer: Joined the staff of Bjorksten Research Foundation, Madison, Wis., as histochemist.

David Binch: Promoted to the position of manager of engineering at American Super-Temperature Wires, Inc., Burlington, Vt.

Max H. Leavenworth: Named manager of market research for Dow Corning Corp., Midland, Mich.

Robert J. Asman: Joined PneumoDynamics Corp., Cleveland, Ohio, as secretary and chief legal officer.

Richard J. Gardner: Appointed senior sales representative for the Los Angeles district of B. F. Goodrich Aerospace and Defense Products Div. of the B. F. Goodrich Co.

James G. Houser: Named director of advanced programs for the Martin Co.'s Orlando, Fla., division.

Peter Karter: Appointed manager of technical development in nuclear technology for AMF Atomics division, American Machine and Foundry Co.'s Advanced Products Group, Greenwich, Conn. **Torben R. Dreyer** appointed assistant group executive for manufacturing of AMF's Advanced Products Group.

Lt. Col. Stanley C. White: 1962 Laureate of International Academy of Aerospace Medicine, returns to the Air Force's Aerospace Medical Div. at Brooks Air Force Base, Tex., effective July 2, after serving at NASA's Manned Spacecraft Center.

Rollin Gillespie: Formerly with Lockheed Missiles and Space Co., named chief of planetary missions planning, National Aeronautics and Space Administration headquarters, Washington, D.C.

Dr. Chalmers W. Sherwin: Vice President and general manager of Aerospace Corp.'s Laboratories Div., selected by Dept. of Defense as deputy director of research and engineering for research and technology. Effective about June 1.

Sherman C. Maple: Appointed director of operations of American Laboratories, a section of American Electronics, Inc., Fullerton, Calif.

Dr. Frank S. Stein: Joined the Delco Radio Div. of General Motors Corp., Kokomo, Ind., as a senior scientist.

Charles W. Frick: Rejoins General Dynamics/Convair, San Diego, Calif., as vice president-engineering on May 1.

David S. LeVine: Named assistant general manager of site activation at the Martin Co.'s Denver, Colo., division.

E. R. Kearney: Named head of Thiokol Chemical Corp.'s Wasatch Div.'s Product Development Dept., Brigham City, Utah.

Norman O. Ranz: Appointed director of government programs for Gulton Industries, Inc., Metuchen, N.J.

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AIEE Rubber and Plastic Industries Conference, Sheraton Hotel, Akron, Ohio, April 22-23.

IAS National Meeting on Manned Space Flight, Marriott Motor Hotel, Dallas, April 22-24.

American Physical Society Meeting, Washington, D. C., April 22-25.

Hypersonic Ramjet Conference, sponsored by ASME, AIAA, and U. S. Naval Ordnance Laboratory, White Oak, Md., April 23-25.

National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, April 23-25.

AIEE Power Industry Computer Application Meeting, Westward Ho Hotel, Phoenix, Ariz., April 23-25.

AIEE Southeast District Meeting, John Marshall Hotel, Richmond, Va., April 24-26.

IRE Regional Technical Conference, San Diego, Calif., April 24-26.

Society for Industrial and Applied Mathematics Spring Meeting, Stanford Research Institute, Menlo Park, Calif., April 26-27.

AIEE Electro-Nuclear Meeting, Richland, Wash., April 29-30.

Institute Society of America, National Analysis Instrumentation Symposium and Exhibit, Rice Hotel, Houston, April 29-May 1.

American Society of Tool and Manufacturing Engineers, Annual Engineering Conference and Exposition, International Amphitheater and Conrad Hilton Hotel, Chicago, April 29-May 1.

Society of Photographic Scientists and Engineers, Annual Conference, Ambassador Hotel, Atlantic City, N. J., April 29-May 3.

MAY

American Institute of Electrical Engineers, Great Lakes District Meeting, Blackhawk Hotel, Davenport, Iowa, May 1-3.

Third National Conference on the Peaceful Uses of Space, sponsored by NASA and Committee for Economic and Cultural Development of Chicago, Chicago, May 1-9.

AIAA and Aerospace Medical Assn., Manned Space Laboratory Conference, Statler-Hilton Hotel, Los Angeles, May 2.

Institute of Radio Engineers, National Symposium on Human Factors in Electronics, Marriott Twin Bridges Motor Hotel, Washington, D. C., May 2-3.

American Institute of Chemical Engineers National Meeting, Statler-Hilton Hotel, Buffalo, N. Y., May 5-8.

Aerospace Reliability and Maintainability Conference, sponsored by ASME, SAE and AIAA, Marriott Motor Hotel, Washington, D. C., May 6-8.

Instrument Society of America, National Aerospace Instrumentation Symposium, Jack Tar Hotel, San Francisco, May 6-9.

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Center of Controversy

ONE OF THE MORE controversial items in the projected Fiscal 1964 NASA budget is the agency's request for initial funding of a planned $50-million Electronics Research Center in the Greater Boston Area.

In view of Sen. Ted Kennedy's campaign pledge to "do more" for Massachusetts, it perhaps is inevitable that the location and need for the center are being questioned on political grounds. This is unfortunate.

The judgment by Congress should be made principally on the basis of whether or not the center actually is needed by NASA. A thorough examination of the planned location also should be made without regard to its political advantages.

Equally unfortunate is the fact that the White House itself is bringing political pressure to bear in favor of the center. This certainly increases suspicion of political motivations.

There is little question in our mind that the requirement for such a center should be carefully examined. As yet, NASA does not appear to have made a strong case for it.

Plans for the center call for an initial expenditure of $5 million during FY '64. Over a six-to-seven-year period, the center will be built up to a staff of some 2000 and a capital investment of some $50 million. Congress has been told that annual operating expenses then will be about $28 million.

NASA's recent record in holding to such commitments has not been inspiring. The Manned Spacecraft Center at Houston was sold to Congress two years ago as a $60-million center. Within months, the figure climbed to $90 million, and the space agency recently jumped this to $200 million.

The annual operating cost also is exceedingly low in comparison with other electronics centers with a comparable or lower level of effort.

The Naval Research Laboratory is a $55-million facility. Its Fiscal 1963 budget is $68 million, significantly more than NASA is estimating for a $50-million installation.

The NRL operation also gives rise to another question about the proposed Boston electronics center. Official Navy estimates show that one-half of the NRL staff is engaged in electronics research. In FY 1960, space-related research by NRL totalled some $22 million.

This is but one of many government centers engaged in electronics research. The Air Force electronics research effort at Cambridge is on a level well over $60 million. The Army has a number of centers engaged in similar activity. Ft. Monmouth, with an electronics staff of 3500, is spending some $28 million in-house; Ft. Huachuca's Electronic Proving Ground, with a staff of nearly 10,000, some $26 million.

Overall, the latest complete figures for government-sponsored in-house electronics research and development total well over $246 million. That was in Fiscal 1960; the effort has increased substantially since then.

At the same time, a Senate Government Operations subcommittee under Sen. Hubert Humphrey (D-Minn.) has reported that as much as one-tenth of all government-supported electronics research and development may consist of "unwitting, needless duplication of effort." That is, some $200 million out of an expenditure of $2 billion in 1960.

Albert J. Kelley, Director of Electronics and Control for NASA, told the House Space Committee the new center will not only direct electronics research but will do research in communications, data processing, guidance, instrumentation and control.

"It will be staffed and equipped to perform original work," he stated. He also noted that component test facilities will be provided to evaluate industrially developed experimental components.

A good argument can be made that the electronics firms in this industry already are fully capable of such basic work in electronics.

NO ONE CAN QUARREL with NASA's need for a capable electronics management group. As Mr. Kelley himself says, "NASA simply must have qualified people on its staff who are well informed on space missions and their related electronics systems performance requirements, able to identify the problem areas, and competent to evaluate the research results of others."

But whether the proposed Electronics Research Center is needed to develop and support this group is a question that deserves careful study.

So does location of the center in Boston.

Kelley has this to say on that subject: "The NASA considered many potential sites throughout the country for location of the Electronics Research Center. On balance, the overall university-industrial strength and capability in electronics and guidance in the Greater Boston Area resulted in its selection as the location for the Center. This area, noted for its past and current heavy concentration on electronics research, both in industry and universities, provides a compatible, stimulating environment for growth of NASA capabilities in this important area . . ."

We would like to ask if these same criteria were applied in the selection of Houston as a site for the Manned Spacecraft Center. What compatible, stimulating environment brought about that selection? What industrial strength and capability did Houston offer in manned spacecraft?

If, as Mr. Kelley himself states, 70% of major spacecraft dollars now go into electronics, why wasn't Boston chosen as the site for the manned spacecraft center? Or conversely, if 70% of the dollars now being spent on manned spacecraft involve electronics, why do we need the Boston center in addition to the Houston center? Could the center, if needed, be located elsewhere—say, the Midwest—to stimulate the space industry there?

We hope Congress will carefully consider all such questions before voting the funds requested.

William J. Coughlin

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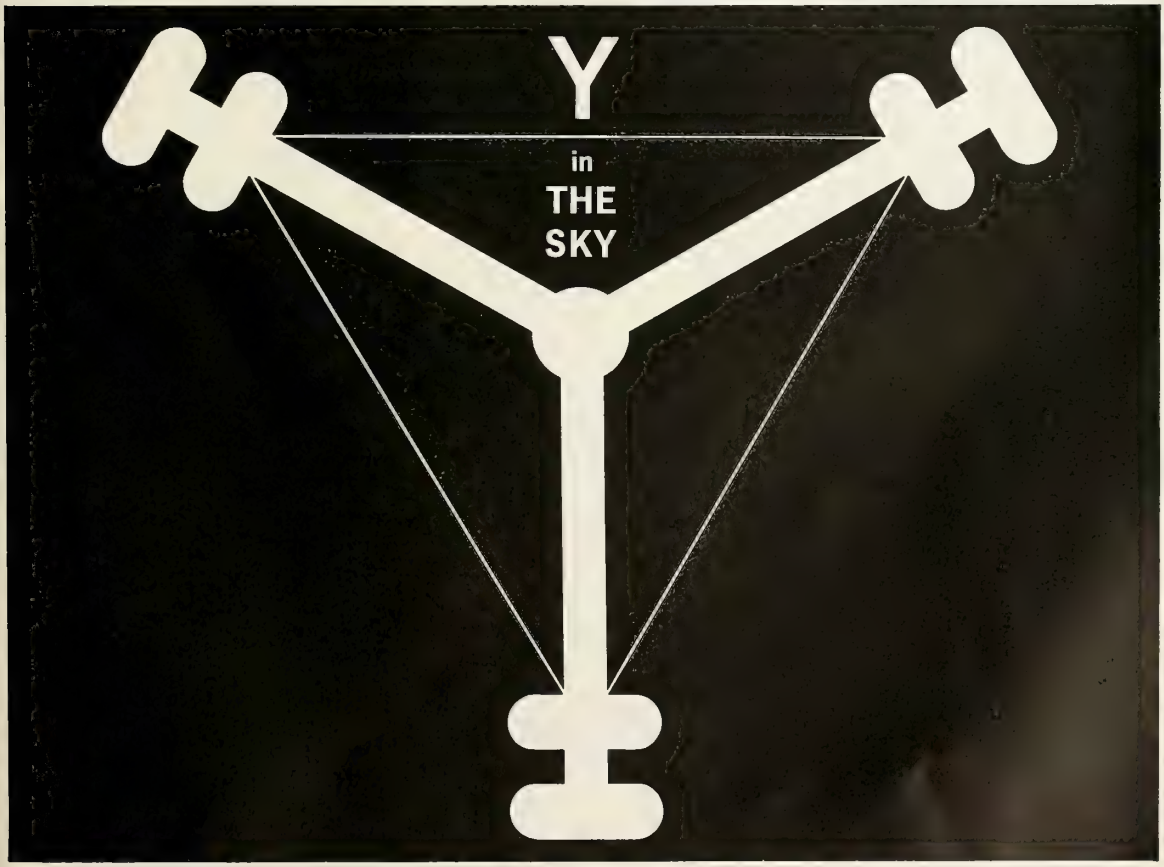
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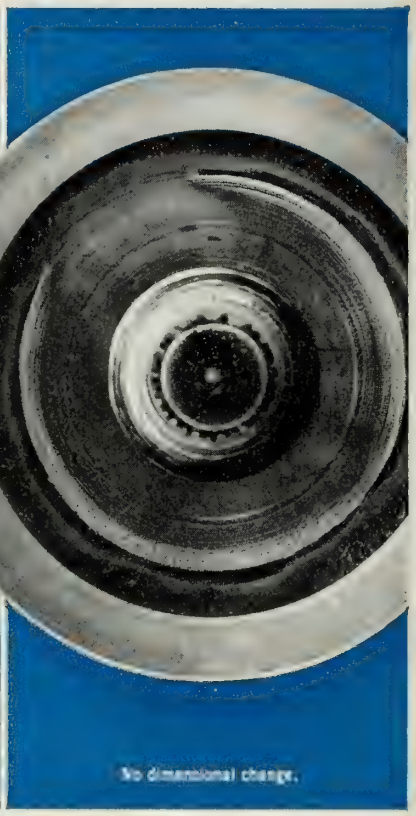


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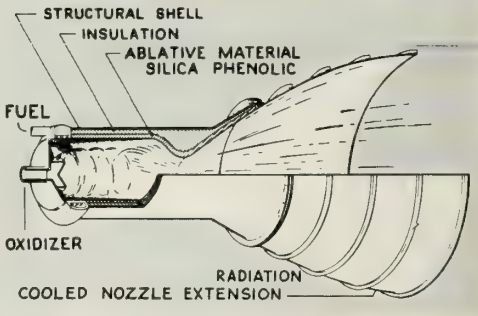
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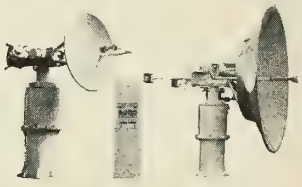
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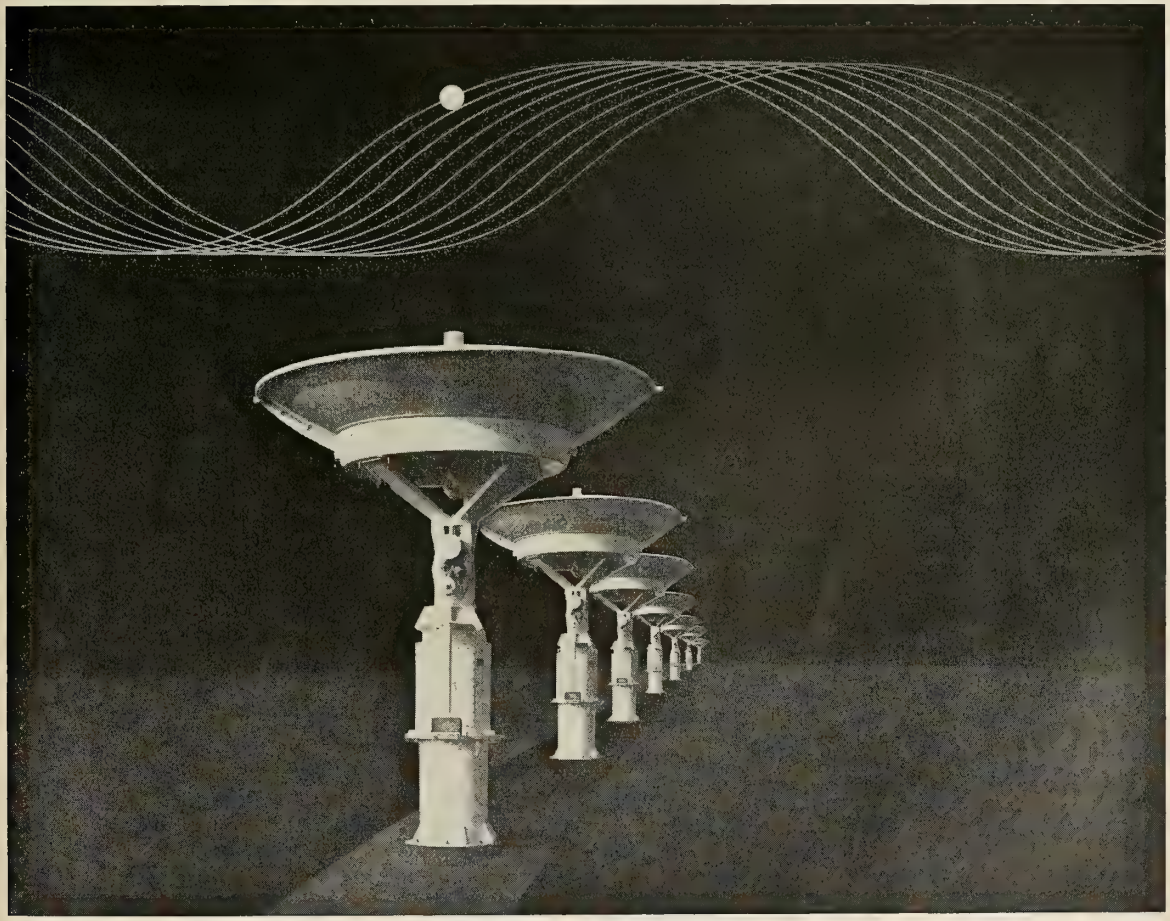
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THE COVER



More than 115 materials which may be used in Honeywell-developed Apollo stabilization and control system are tested at the firm's Aeronautical Div. in Minneapolis. Test specimens are suspended in 100% oxygen in temperatures from 800 to 900°C.

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letters

PERT from Inside

To the Editor:

I always take great interest in reading the last-page editorial in MISSILES AND ROCKETS. I took particular interest, however, in reading your April 15 analysis of "Management of Mediocrity."

I have been involved with the PERT technique and approach since its initial effort with Admiral Raborn. Actually, I have been involved in this technique since 1956, whereas I called my version Tech-Plan rather than PERT. I only mention this and include a little background of mine to justify my authority or knowledge in what I have to say in this letter.

In a sea of people selling the PERT panacea approach, and amongst many people taking advantage of you've got to be for motherhood and against sin, I seem to be an individual. While I firmly believe that PERT, PERT-time and PERT-cost can, if used effectively, be an effective tool of management, I further emphasize that this tool is worthless unless the data fed into it is of value. The basic problem that has faced this country for more than the 23 years that I have been dealing in the aerospace field is that the structure of defense proposal and procurement is based upon arbitrarily established time and budget requirements. These arbitrarily established time and budget requirements are not connected to or directly related to the capability of the country to design and produce a weapons system nor the actual cost that this system is going to incur.

Whereas the PERT technique could be a tool of doing this, to date no branch of the military services have developed a contactual set of specification requirements which will guarantee to make PERT work realistically. PERT cannot work until there is a way in which a proposal effort can be completely valid from time and cost standpoints, without any danger of the proposing organization losing out on the contract because his proposal, although valid, does not match weapons management/customer's original desires or requirements.

One estimate of the money spent to date on PERT was $200,000,000. The validity of this estimate is unimportant. What is important is the indication of the scope of funding invested in this management science approach. Most of the money spent to date on PERT has been spent on developing PERT technique, developing what PERT is and how to computerize PERT. The more difficult job of how to make PERT work and guarantee valid results has been hardly tackled at all.

To summarize the above, "To Make PERT Work" means to solve the basic problem of schedule and budget validity that faces the defense effort today. This may be the most important problem that we have to solve in our current Cold War.

C. K. Simon
Vice President
Management Methods Corporation
Sacramento, Calif.

Engineering Documentation

To the Editor:

During the next few months I will be making a comprehensive study of the present and future engineering documentation system needs of the U.S. Army Missile Command. The Command maintains an engineering drawing library at its Huntsville, Alabama, Documentation Center consisting of approximately 1,500,000 microfilm aperture cards in its current or working file and 4,500,000 cards in its historical or master file. These cards constitute a complete library of engineering drawings on all Army missile systems.

This is one of the largest such documentation centers, in a single location, in the world. The sheer size of this operation creates many problems of filing, retrieval, reproduction and distribution, as well as special problems such as "out-of-file" conditions, which do not exist in smaller centers.

To keep abreast of these problems, the Command has long been a leader, first in microfilming and subsequently in microfilm automation. However, as our documentation center continues to grow and its usage volume increases, we anticipate further problems. We are now planning for increased automation and mechanization during the immediate 2-7-year period, and concurrently are attempting to look still further ahead, at the 8-15-year period when radical changes will have taken place in engineering drawing portrayal and display methods, when in fact drawings may not be on paper or microfilm at all, but on TV tape or even as information within a computer.

My study will serve for the present and the immediate future as a reference library on the state of the art of engineering documentation storage and retrieval mechanization and automation, and for the more distant future, as a source of information and recommendations to guide the Missile Command (and possibly the Army as a whole) in long-term planning for the changes that will come in engineering documentation methods and portrayal systems. Portions of this study, in condensed form, will be submitted to the University of Alabama next summer as a Master's Thesis in Industrial Engineering.

In order that the study may be as complete as possible, for the most effective use by the Army and the aerospace industry, I would appreciate any information from industry or from other military installations on the state of the art of engineering documentation automation, and on projected future developments in portrayal and display systems. Please address communications to:

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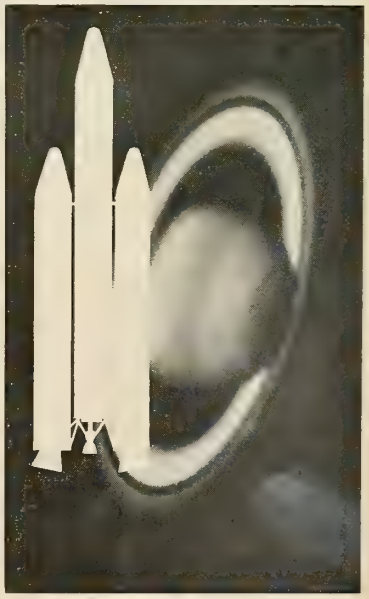
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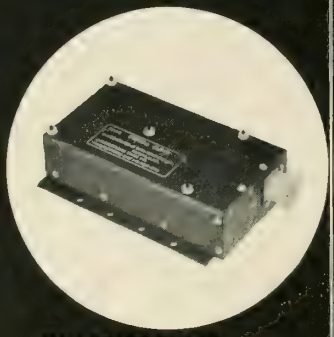
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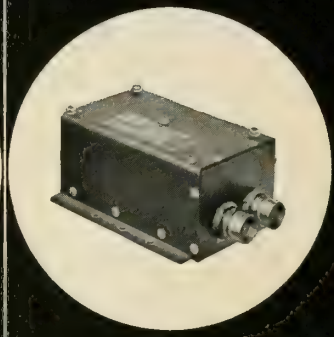
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The Countdown

WASHINGTON

Relay II Launch Is Set for Late Summer

NASA now plans to launch its *Relay II* satellite late this summer. Only small design changes have been made from the *Relay I* configuration, which still is transmitting successfully. Most changes will involve state-of-the-art advances rather than radically new components or subsystems.

Army Defends Large Buy of Hawks

Army sources say enough *Hawk* missiles now are on order to destroy 200% of all Soviet bloc aircraft expected to be operational within the next few years. Congressional criticism of the huge *Hawk* procurement has stemmed from the fact that Army also plans to buy *Mauler* and other antiaircraft systems. But Army spokesmen insist the scheduled figure is a sound one, pointing out that no one suggests buying just one bullet per Russian soldier.

Two Firms Vie for NASA Support Contract

Selection of a NASA contractor for development of a prototype six-month life-support system has been pared down to two companies—General Dynamics/Astronautics and Hamilton Standard Div. of United Aircraft. The space agency says final selection is imminent. Program is under direction of Langley Research Center.

Navy Tests of Hydra Concept Set for Next Month

Navy will begin test-firing the water-based *Hydra-Iris* vehicle next month at Pt. Mugu, Calif. Program, under direction of the Naval Missile Center, is to check out the *Hydra* concept of launching rockets from free-floating, vertically positioned platforms at sea. The two-stage, 1750-lb. recoverable vehicle will carry a 100-lb. instrument payload to 250 mi. altitude. First stage of the 24-ft.-tall booster was developed by the Naval Missile Center and is powered by three off-the-shelf *Sparrow III* motors with a total thrust of 4000 lbs. Second stage is an *Iris* sounding rocket produced by Atlantic Research Corp.

Thresher Was Equipped with Subroc system

Generally overlooked in concern about possible nuclear disaster in the Thresher sinking was the fact that Thresher was the first submarine equipped with the Goodyear *Subroc* system, which carries a nuclear warhead. Loss of the Thresher has been a setback to the program due to its key role in weapons system tests. As soon as the system becomes available, *Polaris* submarines are to be equipped with *Subroc*.

Army Concerned with Davy Crockett Use

Concern has been expressed by the Army that the high cost of *Davy Crockett* launchers is not being adequately justified due to the low number of missiles ordered for each launcher. Army hopes to step up the number of rounds per launcher to enhance the weapon's potential for defending vital areas in Europe.

Navy Plans No More Nuclear Polaris Firings

Navy is not planning any further tests of *Polaris* missiles with live warheads. The one such test conducted last fall in the Pacific has been described as eminently successful. Future practice firings will use only the exercise warhead.

Pershing Overflight Set for August

First overland flight test on the *Pershing*—from Blanding, Utah, to the White Sands Missile Range in New Mexico—now is scheduled for August. Other overland flights of the Martin missile to White Sands will be launched from northern New Mexico.

INDUSTRY

Lockheed Proposes Underwater Missile Base

Among underwater missile base concepts being studied by the military services is Lockheed's "Turtle." This is a submerged missile complex capable of long-range mobility at very slow speed. Manned by a small crew, it could travel to any well protected site on the ocean floor where sonar detection would be made difficult by permanent thermal gradients. Turtle would be considerably cheaper than a high-performance ballistic missile submarine—although not so responsive to sudden changes in the global strategic situation.

Rocketdyne Gets Titan III Contract from Martin

Martin-Denver has awarded a $3.1-million subcontract to Rocketdyne for design and manufacture of the attitude control system of *Titan III*. The system will employ eight small rocket motors attached to the *Titan III* transtage. Four will serve as ullage rockets; four will control transtage yaw and pitch moments during the coast phase.

Florida Capabilities Not Fully Realized?

Top procurement officials from NASA, Thiokol and GE told Florida contractors in a Space Age Forum at Jacksonville last week that they haven't made a sufficient effort to publicize their capabilities. A Thiokol contracts manager said the firm is trying to spread some of its new business into Florida but has been unable to find a source list. The space agency spokesman noted that the Sunshine State has won only 1.7% of NASA contracts awarded in the past six months—worth only $2.5 million.

Lockheed Details Big Solids Program

Lockheed Propulsion Co. reports it will test-fire a number of flyweight rocket motors during the next few months under its new Air Force solids contract. The program will culminate with full-scale firing of a 156-in. solid motor by the end of the year. The Lockheed division, which won package #4 of the big solids program, will develop a system of jet tabs for thrust directional changes.

INTERNATIONAL

European Telstar Reports Miff NASA

NASA officials were not at all pleased when a number of European newspapers lauded *Telstar* for the television transmission of the Washington ceremonies awarding honorary American citizenship to Sir Winston Churchill. AT&T's *Telstar* has stopped transmitting. The ceremonies were telecast via NASA's *Relay* satellite.

Shots of the Week

The third consecutive firing of a solid-fueled *Minuteman* under simulated nuclear war operational conditions was made April 23 from Vandenberg AFB, Calif. Launched from an underground silo by a Strategic Air Command combat crew, it flew 5000 miles down the Pacific Missile Range into the target area.

Two similar previous tests of the three-stage "instant ICBM" from Vandenberg, on April 11 and 12, also met test objectives. The missile in each case was equipped with a mock nuclear warhead.

- The experimental *X-15* rocket ship carried a new "Q" heat meter aloft from Edwards AFB, Calif., on April 18, in an effort to determine why skin temperatures of the craft have been rising to unexpectedly high levels. The ship was flown by Chief NASA Test Pilot Joe Walker.
- Martin *Titan II*, launched April 19 from Cape Canaveral, failed to fly the programmed 5000-mi. mission when its second stage unexpectedly shut down after a 120-second burn. First-stage performance, separation, and second-stage ignition were normal, spokesmen said.
- The Army's Western Electric-built *Nike-Zeus* antimissile missile successfully went through in-flight maneuvers April 24 in a development test over White Sands Missile Range, N. M. The 48-ft. missile, launched from an underground cell, is reported to have executed commands given by ground guidance equipment and to have met all test objectives.
- An Army Martin *Pershing* missile was successfully fired on a minimum-range mission from Cape Canaveral April 24. All test objectives were met.
- Russia launched the 15th shot in its *Cosmos* series April 22. The West German Space Observatory at Bochum reported that radio signals picked up from the satellite indicate it has a bigger task to perform than have its predecessors.

JFK Defends Lunar Program

President Kennedy this week said that he had heard nothing in the recently intensified U.S. man-to-the-moon debate to change his stand that it is a wise and necessary program.

In answer to critics' claims that part of the space budget should be spent on more immediate projects, such as education, he expressed doubt that—if the space program were cut—any more money would be provided for education.

The President also noted that, if the space program were cut now, the Russians might well achieve a spectacular space feat in the future—causing the U.S. to regret its failure to do more in the space effort.

NASA Contract to Martin

NASA has awarded The Martin Co.'s Denver Division a $325,000 contract to study the feasibility of a *Titan II-Centaur* booster combination.

The six-month contract will include preliminary design analysis; mission performance, ground-support equipment and launch facility requirements; development plan, scheduling, and cost estimates.

In announcing the award, NASA's Lewis Research Center—which manages the *Centaur* project—said that the *Titan-II-Centuar* combination is attractive because of an expected large payload gain over the current *Atlas-Centaur* launch vehicle (MISSILES & ROCKETS, March 18, p. 12).

The increased payload capacity is said to be in the neighborhood of 750 to 1000 lbs.

NASA Recruiting Criticized

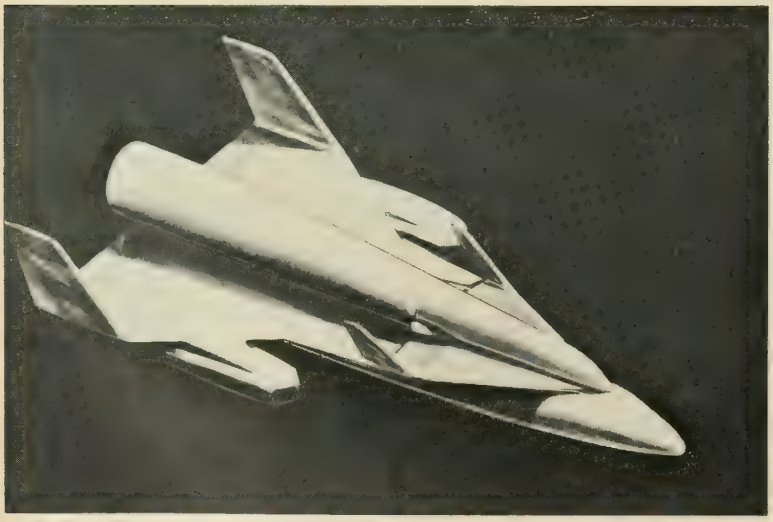
Senate Republicans charge that NASA is starting to invade research territory belonging to the private sector of the economy and is attempting to monopolize U. S. scientific talent.

Sen. Bourke Hickenlooper (R-Iowa) declared that NASA should follow the pattern of the Atomic Energy Commission, which he says promotes private economic interests more effectively.

He was joined, as the Senate Space Committee opened hearings on the space agency's fiscal 64 authorization bill, by Sen. Margaret Chase Smith (R.-Me.), who read a letter charging that NASA is attempting to corner 60 percent of all scientists in the physical sciences.

The letter was written by another Republican, Sen. Wallace Bennett of Utah, after conversations with scientists attending the American Physical Society Meeting in Washington.

Bennett said the scientists "expressed great concern over the present policies of NASA that seem to be to build up a gigantic organization inside the government to carry on basic research in the physical sciences." He added that the scientists described to him instances of what they considered to be coercion in-



Reusable Passenger Ferry Concept

NASA artists's sketch shows proposed vehicle to be used for transporting passengers between Earth and orbit. Vehicle would take off horizontally from a giant sled which would remain on the ground after vehicle reached flight speed. Flight crews would assume control after automatic boost flight and stage separation and fly expended stage back to Earth using air-breathing engines on wings.

tended to force men now working in private industry to give up their jobs and go to work for NASA.

A similar objection to the development of NASA's proposed Electronics Research Center in Boston was voiced recently by another member of the committee, Sen. Clifford Case (R-N. J.).

Case declares that firms in New Jersey and Boston have complained to him about the Center. Among other things, he said, the firms are afraid of losing valued employees to the new NASA facility.

NASA Administrator James E. Webb, defending the space agency against the charges, told the committee that NASA intends to use in-house only 1% of the nation's physical scientists and only another 7% through its contractors.

New Trade Journal Announced

American Aviation Publications, Inc., publisher of MISSILES AND ROCKETS, has announced the introduction of *American Aviation* magazine, a new monthly trade journal devoted exclusively to the aviation industry. The first issue, in July, will have a circulation of 45,000 copies.

American Aviation will absorb *Airlift* and *Skyways*, both currently published by AAP as separate magazines.

LeMay Urges Military Space

Air Force Chief of Staff Gen. Curtis LeMay told the House Defense Appropriations Subcommittee in testimony released last week that the Soviet Union can, if it wishes, place a missile-launching platform in orbit.

LeMay said: "They have put a satellite in orbit and launched a missile from the satellite, so I think they could probably do that."

The General indicated that he does not believe "this would be a very efficient way to launch missiles," however; and he made it clear in the testimony that he is more interested in obtaining a broader space role for the Air Force than in developing an orbiting space force. The only offensive space capability LeMay mentioned as desirable at this time would be designed to destroy enemy reconnaissance satellites.

On the subject of peaceful space exploration leading to a manned lunar landing in this decade, LeMay was more definite. "I would rather be going to the moon for military reasons," he told Chairman George Mahon (D-Tex.). Mahon had asked whether it is fiscally wise to press so



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hard on this program, in view of current budget pressures. LeMay said that he believes the stress in such a program should be on the military aspects—"In other words, aim it as a military project, rather than just a scientific project; let science fall out, rather than let the military applications fall out."

USAF Cancels Star Gazer

The Air Force has announced its intention to discontinue the Star Gazer manned balloon project.

Project director Dr. Allen Hynck gave lack of funds as a reason for the cancellation. A quarter-million dollars have already gone into the project.

The project had called for sending a manned balloon with telescopes to 100,000 feet to observe the stars from an altitude relatively free of aberrations caused by atmosphere.

On-Board Recorders for Gemini

A pair of small biomedical tape recorders, weighing less than 6 lbs. and occupying less than 125 cu. in., will accompany the *Gemini* astronauts on their spaceflight next year.

For 30 hours continuously, each recorder will simultaneously record six different signals received from sensors within the astronauts' spacesuits. Also, each will have two extra reels, providing enough tape to record up to 90 hours of biomedical data.

Said to be the smallest ever developed for such an operation, the recorders will be built by Technical Center Division of Cook Electric Co., Morton Grove, Ill. Each seven-channel recorder will simultaneously register electrocardiograph readings, blood pressure and respiration. One channel will register time, and the Manned Space Center will establish other parameter readings for the devices.

Until now, biomedical data on astronauts in orbit have been transmitted to ground stations by telemetry, and recorded on larger, ground-based devices.

Explorer Data Viewed

The *Explorer XVII* satellite has discovered that the Earth is surrounded by a belt of neutral helium atoms.

NASA's Goddard Space Flight Center scientists reporting to the American Geophysical Union meeting in Washington April 18 said satellite data being sent back to Earth are giving the scientists their first actual measurements on neutral gases in the satellite's particular orbital path, including pressures, densities and temperatures.

The reports given were based on eight hours of preliminary data received at the Blossom Point, Md., tracking station on April 3, one day after launch.

At the satellite perigee of 150 miles, independent instruments showed that there are about 60 million neutral helium molecules per cubic centimeter— a volume roughly the size of a sugar cube. At the satellite's apogee, 575 miles, there are only about one million helium molecules for the same volume.

Experimenters noted that the neutral helium layer begins about 60 miles below the altitude where space researchers first measured an electrically charged belt of helium some two years ago with daytime and nightime probes, the *P-21* and *P-21A*.

Satellite pressure gages showed that, at perigee, pressure is about one-hundredth of one-billionth that of the Earth's atmosphere at sea level. Data on pressure at apogee has not been analyzed, but experimenters expect it to show readings of only one-trillionth of the Earth's atmosphere at sea level. The atmospheric

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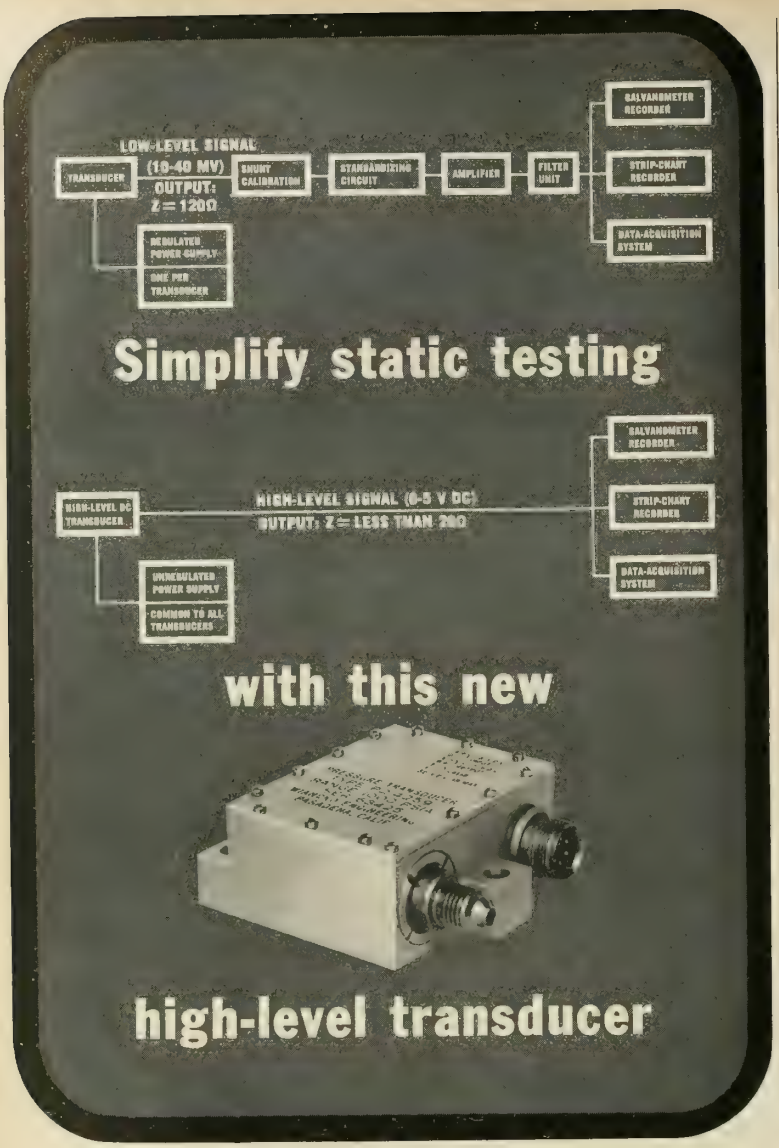
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density measured by the satellite at perigee was determined to be 2.7×10^{-8} grams per cubic centimer.

Several measurements of electron temperature confirmed other satellite data which showed that these temperatures vary from day to night, and that electron temperature at apogee and perigee remains near the same level during the night. The nighttime electron temperature is about 950°K (1070°F), and the daytime temperature is about 2200°K (3500° F).

Rep. Thomas to Retire

Rep. Albert Thomas (D-Tex.) has announced that he will retire at the end of the current Congressional term.

In his position as House Appropriations Subcommittee chairman, Rep. Thomas has wielded considerable influence over the apportionment of funds for the U.S. space programs.

COSPAR Moves to Paris

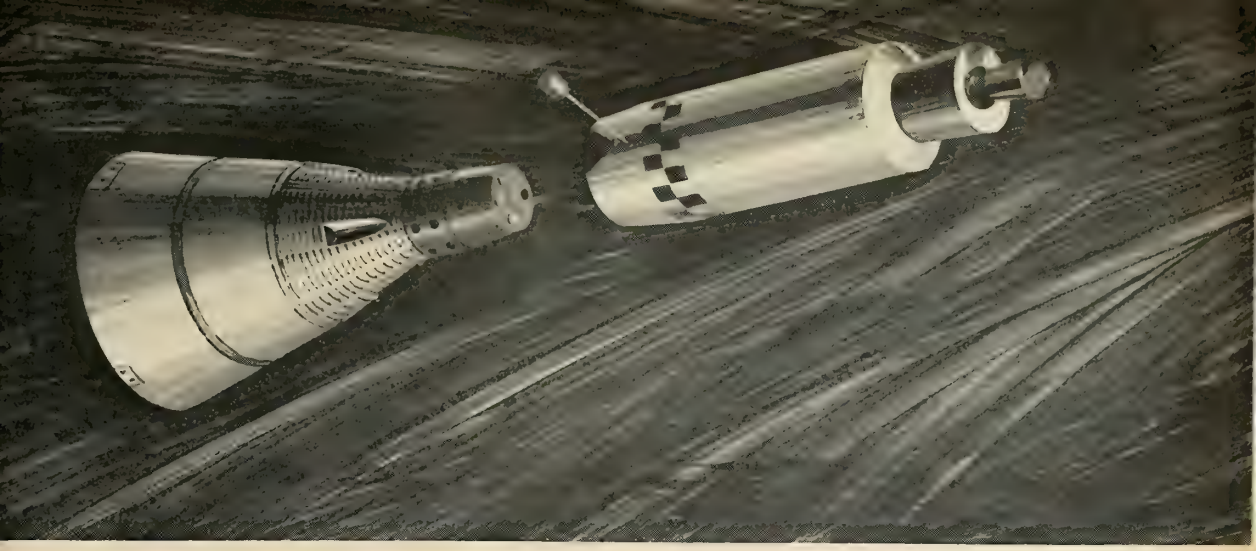
The latest international space body to move to Paris is the multinational Committee on Space Research, which will shift its secretariat from The Hague on May 1. COSPAR's address will be 55 Boulevard Malesherbes, Paris 8 (Phone LABorde 1993; cable address COSPACERES PARIS). Other international space organizations already established in Paris include Eurospace; the International Astronautical Federation; the European Preparatory Commission for Space Research, which will soon be replaced by the European Space Research Organization (ESRO); and the Europeon Launcher Development Organization (ELDO).

Polaris Planners Praised

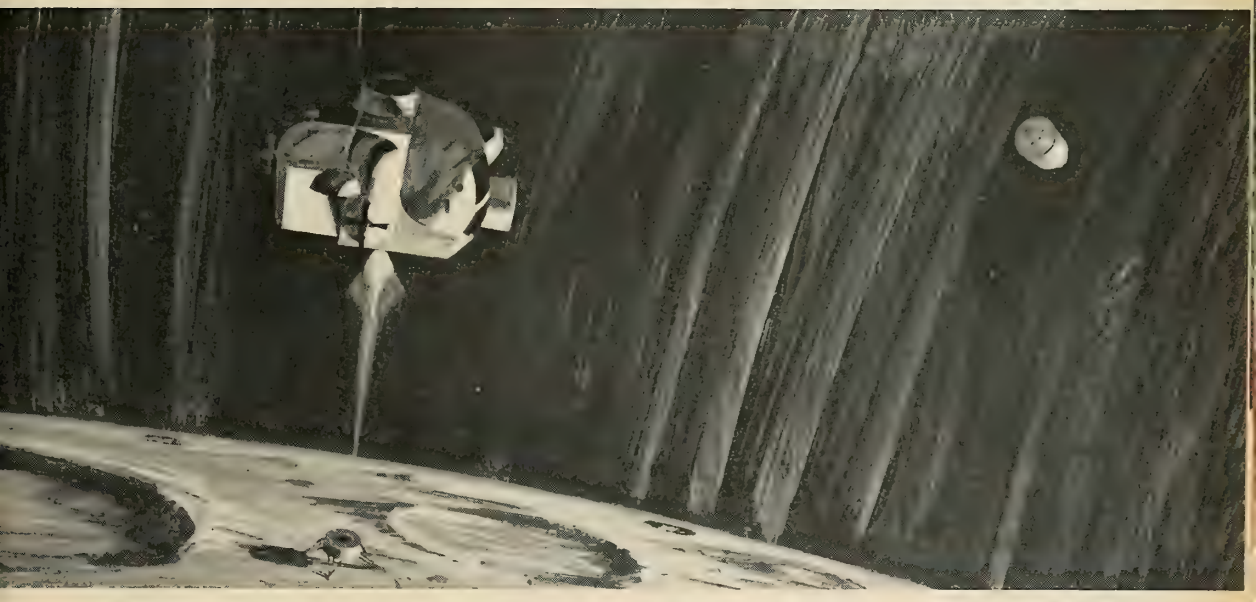
Predictions on 1963 state-of-the-art made by the *Polaris A3* program steering committee in 1956 have turned out to be "extremely accurate," says Capt. William A. Hasler, Navy plant representative at Lockheed Missiles & Space Co. at Sunnyvale, Calif., who has been with the program since its inception.

Hasler credits ability to reach early accord on parameters for each subsystem as a major factor in the program's success. The basic parameters "remain unchanged" today, he said.

Of the *A3 Polaris* program, Hasler said that despite early failures, "we have as much confidence in the *A3* concept as we did in the *A1*."



Westinghouse radar will guide the first orbital rendezvous



Westinghouse is working on advanced radar systems for deep space missions

When the Gemini two-man spacecraft first performs rendezvous and docking maneuvers in earth orbit, a new Westinghouse radar system will help assure the success of the mission.

The Gemini spacecraft itself, one important mission of which is the perfection of rendezvous techniques, is being built by McDonnell, prime contractor for the Gemini project, under the technical direction of NASA's Manned Spacecraft Center.

Using a unique interferometer system developed by Westinghouse's Air Arm Division, the spacecraft interrogator will transmit a series of pulses to the target transponder. Reply pulses received by the spacecraft will be used to measure range and azimuth and elevation angles.

The first of its kind in space, the Westinghouse radar system for Gemini is the beginning of a new generation of advanced radars for deep space missions, lunar landings, planet exploration and space station logistic support.

For more information on Westinghouse Air Arm Division space programs, write for new brochure, "Into Space," to Westinghouse Electric Corporation, P.O. Box 868, Three Gateway Center, Pittsburgh 30, Pa. You can be sure...if it's Westinghouse.

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Nova Decision May Be Far Away

NASA official cites high cost of huge booster; post-rendezvous maneuvers by Gemini outlined; other highlights of flight meeting

by Russell Hawkes

DALLAS—The projected *Nova* launch vehicle would be so costly that it would require a national policy ruling on the order of President Kennedy's decision to award high priority to the manned lunar landing program, a NASA official has declared.

There is no need for a decision on *Nova* until 1968 at the earliest, John W. Stone, advanced studies manager of the Launch Vehicle Directorate of NASA's Office of Manned Space Flight, told the American Institute of Aeronautics and Astronautics here last week.

This was believed to be the first statement by a ranking NASA official that resolution of the long-pending *Nova* question might be deferred for five years or longer. *Nova* would have several times the payload of *Saturn V*.

Stone's remarks stirred considerable interest at the AIAA's second annual Manned Space Flight meeting, attended by 1100 members.

There were these other developments:

—Cost of even a four-to-six-man space station was set as high as $2 billion by Thomas E. Dolan, of the National Aeronautics and Space Council's professional staff. Dolan urged use of such a station, with a weight of 20,000 lbs. and a one-year operational lifetime, as the basis on which to evolve more advanced stations. The initial stations would serve as building blocks (see p. 18).

—The first major requirement for military men in space may be a maneuverable command post in space for all U.S. armed forces, said Gen. Thomas S. Power, commander of the Air Force's Strategic Air Command.

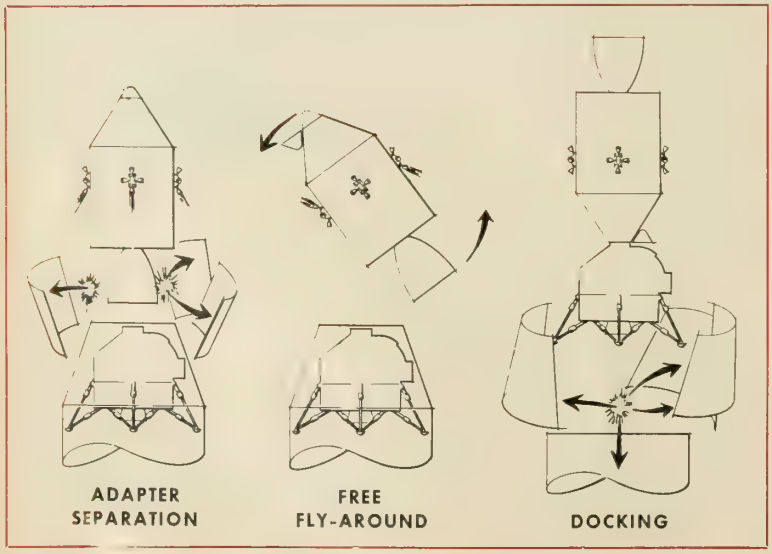
Power said that such a spaceborne command post eventually might be the "only really survivable command and control structure" for U.S. defense. "It is inconceivable," he added, "to operate such a central command post, especially one in deep space, without a skilled crew to operate and maintain its complex equipment, and without competent officers fully qualified to assume command of the strike forces whenever necessary."

• **Gemini and Agena**—Post-rendezvous maneuvers by *Gemini* spacecraft using the propulsion system of the *Agena* target vehicle—and the design and mission constraints they require—were outlined by James A. Chamberlin of NASA's Manned Spacecraft Center.

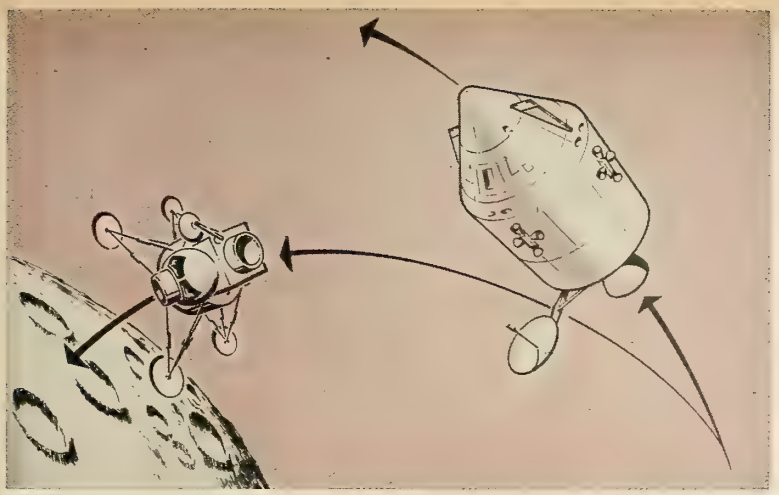
Chamberlin pointed out that the *Agena* modified for post-rendezvous thrust maneuvers will have to be manrated to some extent, and instruments will have to be provided to permit astronauts to monitor engine start and operation. Since NASA intends to conduct these maneuvers on the second day of planned *Gemini* missions, launch and rendezvous will have to be completed on the first day.

NASA engineers are now deciding between two variable-azimuth launch techniques intended to keep the orbital planes of the two vehicles close together, so that the rendezvous can be completed in this time and with a minimum expenditure of fuel.

The fuel requirement sets the maneuvering capability needed to solve the terminal guidance problem. Use of one of the variable-azimuth launch techniques is supposed to keep the plane change requirement simple enough to be solved by the astronauts and their on-board equipment.



DRAWINGS released by North American at AIAA meeting show how LEM is moved from base of service module to neck of command module for crew transfer. Keeping LEM on S-IVB until maneuver is finished minimizes tendency of modules to bounce.



LUNAR DESCENT after two members of the three-man Apollo crew have transferred to the Lunar Excursion Module (LEM) from the command module. North American Aviation artists's drawing shows strakes on command module to improve stability in event of a sub-orbital abort and to help prevent re-entry in wrong attitude.

The *Agena* target vehicle is to be launched first. If the *Gemini* can be launched at the optimum time, the mission will progress directly from the launch phase to the terminal phase. If such a perfect launch can be accomplished, there will be surplus maneuvering capability beyond that required for the nominal mission. The missions will be kept flexible, so that on-the-spot decisions can be made to use the surplus capability to achieve secondary goals.

Gemini systems will permit two days of operations, and *Agena* systems will permit five days. Thus there are from three to five possible launch days for the *Gemini* spacecraft after *Agena* launch. The post-rendezvous maneuver requirements will determine the final selection of launch day.

The size of the launch window which must be hit by *Gemini* is very sensitive to variations in the inclination of the orbital plane. NASA has picked an inclination of 28.87 degrees to get the best launch window and minimize propellant requirements.

● **Catching up**—One of the two methods being considered for the terminal maneuver uses orbital mechanics to simplify the intercept problem for the chase vehicle. By minimizing propellant requirements, this enables *Gemini* to cope with a larger error in its initial orbit. It requires a spacecraft radar with angular measuring capability and an onboard computer.

A second method, based on optical guidance, does not use orbital mechanics to simplify the problem and requires more fuel. Its advantage is a minimum hardware requirement. The astronauts must be supplied range and range-rate information, but this can be done with very simple equipment, perhaps a mere reference grid on the window.

NASA calculations show that 29 orbits can be used for the *Gemini* chase to catch up with the *Agena* target. The lower initial orbit of the *Gemini* will give it a catch-up rate of 5.5 degrees per orbit. This sets the maximum phase difference between the two vehicles at 160 degrees, which corresponds to 43 minutes of launch window.

Out-of-plane error can be corrected by launching *Gemini* on an azimuth parallel to the track of the target as it passes Cape Canaveral. The two orbital planes will then intersect 90 degrees and 270 degrees from the point of launch, and the plane change can be accomplished. The parallel-azimuth technique requires no additional launch system performance and presents a comparatively simple guidance problem.

A second variable-azimuth technique uses a yaw maneuver of the launch vehicle in the latter part of its flight to correct the angular difference between orbital planes. The energy required for this correction is minimized by selecting a launch azimuth to get the closest possible approach to the plane of the target. It has the disadvantage of requiring additional launch system performance.

Additional highlights of the AIAA meeting included:

—Electropropulsion systems are now sufficiently proven to move into production engineering, said Russell D. Shattuck and Robert Dennington of Lewis Research Center. A major remaining problem is extension of the lifetime of electric engines. Until recently lifetime was measured in minutes, but a 30-kilowatt arc jet engine has recently been operated for several hundred hours. Paradoxically, more trouble is being met in the development of smaller arc jets in the two kilowatt range. The primary problem is nozzle erosion.

—Plans to depressurize the *MA-9* spacecraft of Astronaut Gordon Cooper to test the spacesuit have been abandoned, according to Dr. Robert R. Gilruth, director of the NASA Manned Spacecraft Center. Gilruth said there will not be time for such a test.

—Design proposals for three space stations and two Earth-to-orbit logistic vehicles are to be received by NASA by May 14 and study contracts are expected to be awarded within a month. Two contractors will be selected for each study and any further development would presumably go to the winner. ■

Value Engineering Clauses May Change

RE-EXAMINATION of the Defense Department's value engineering program may result in revision of the value engineering clauses for future contracts. The Armed Services Procurement Regulations (ASPR) Committee —which met last week on the subject in response to industry and military complaints—is expected to announce its recommendations within 90 days.

Most likely result is the removal from the VE clauses of certain points that have made administrative and legal difficulties for DOD and for industry. The VE portion of ASPR 13 has been withdrawn temporarily, to allow time for evaluating the situation.

Allowability of costs in the VE program have been questioned, and some industry sources have shown discontent with the way the program is being placed on the contractor for fulfillment.

"DOD wants this program instituted, but doesn't want to pay for it," one industry spokesman charged, summing up a common criticism of the VE effort.

Pentagon sources, however, cite this as a misunderstanding on the part of industry. They see the program as a medium through which industry can recommend improvements in weapon system requirements—and be paid for doing it.

This, DOD believes, is a more realistic way of looking at the objectives of the value engineering program. The services have had certain VE clauses for internal use for some time, DOD says, but these clauses prompted varying interpretations and actions. The intent now is to clear the air by instituting of a consistent expression of the objectives.

NASA Starts Manned Station Studies

Langley-directed plan involves four-man, one-year station; three MSC proposals would provide larger, follow-on systems

by Hal Taylor

FOUR STUDIES of Manned Orbiting Space Stations are being initiated by NASA in a drive to set design specifications soon enough for inclusion of the program in its Fiscal 1965 budget.

The package covers all system designs under serious consideration by space agency officials.

One plan, under direction of the Langley Research Center, calls for a study of a four-man station with an orbital lifetime of one year. This probably will be the first station to get program approval—primarily because of its lower cost and earlier availability.

Three other studies, funded for a total of $550,000 by the Manned Spacecraft Center, call for preliminary design of larger orbiting systems that could be launched in 1970 as a follow-on to the smaller station.

Studies of the larger systems include: $300,000 for a rotating station with artificial gravity; $150,000 for a large zero-gravity station; and $100,000 for a logistics system that would use the *Apollo* spacecraft to carry 10,000 lbs. of cargo or as many as 12 crewmen.

Both NASA centers have asked that only aerospace firms with spacecraft experience submit bids. Proposals on the logistics system are due May 10; those for four-man and rotating stations on May 14; and those for the zero-gravity non-rotating station on May 17.

All of these studies are planned to be completed in time for a space agency decision on whether to include hardware development funds in its Fiscal '65 budget. Commitment of hardware money will have to be coordinated with the Defense Department under the terms of the NASA-DOD *Gemini* agreement.

NASA headquarters officials now favor building the smaller station which would be flown concurrently with the *Apollo* program. It would be used to gather information on the effects of long periods of weightlessness, and as a test bed for components of larger stations to be developed later.

The heavier stations—which could be either rotating or non-rotating—would be used for scientific experiments in Earth orbit, as well as for development of systems and subsystems for manned interplanetary flights.

The Langley request for proposals on the small station calls for two parallel comparative studies of alternative designs. Proposals will not be restricted to a four-man station, and the bidders may consider a three- or six-man station.

● **Two phases**—Phase I of the study will last three months. Phase II, for which a contractor will be selected later, will call for preliminary design and preparation of cost estimates, as well as for the building of mockups.

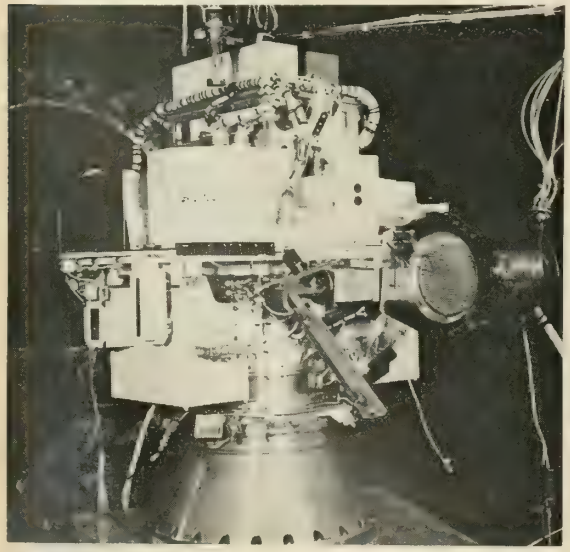
One design which the firms will study is a NASA concept making maximum use of current manned spaceflight programs.

According to the concept, the laboratory would be launched by a *Saturn I* or *I-B* into a circular orbit from Cape Canaveral. After a checkout period, two crew members—using the *Gemini* spacecraft currently being developed—would ascend to the laboratory's orbit and complete a rendezvous and docking maneuver. Later, two more crewmen would join those at the laboratory by the same method, to complete the four-man crew.

At intervals of 90 days or less, an unmanned resupply spacecraft, launched by an *Atlas-Agena* combination, would be orbited and guided by radio control to a rendezvous with the laboratory. One man could enter the laboratory at each crew change, thus providing a check on the cumulative effects of weightlessness on man's total capability.

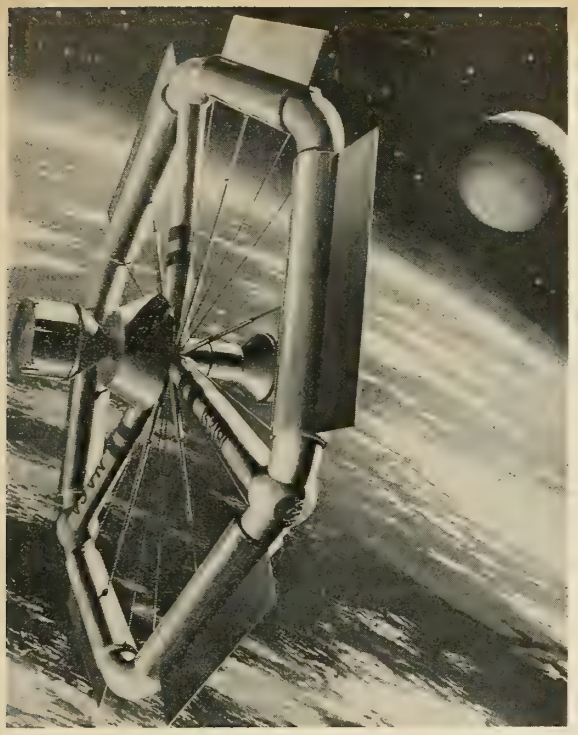
● **MSC concepts**—The Manned Spacecraft Center study contracts—to last seven months—call for much larger stations, which could hold from 25 to 36 men.

Both of MSC's space station concepts should be compatible with the size and weight of the third stage of the *Saturn V* launch vehicle.



SERT Nears First Flight

NASA photo of SERT I capsule in a simulated altitude test. The capsule, containing two ion engines which will undergo environmental testing, will be launched in a ballistic trajectory from Wallops Island during the next six months.



NASA artist's concept of a rotating multi-man Manned Orbiting Space Station similar to that which will be studied under a request for proposals recently issued by the Manned Spacecraft Center.

Planned orbit would be 200 to 300 miles, with an orbital lifetime of one year. This could be extended to five years with resupply and repair by crew members.

The rotating station would have three radial arms and a diameter of 150 ft. It would also have primary and backup docking areas which crewmen could reach without leaving the station. Each radial arm would house six astronauts for a total of 18 crewmen. This could be increased to 36 in an emergency. MFC also has asked contractors to propose an alternative for the rotation station design.

The zero-gravity station would be non-rotating. MSC engineers conceive of it as a large cylindrical station with separate compartments. It should hold 25 to 30 men, a spokesman said.

The requests for proposals specify that the men aboard the station would have primary command of operations, with only one contact with the primary ground control center each day.

The logistics vehicle, center officials say, should be of a soft-landing type having a lift-drag ratio of about 0.25.

The reusable vehicle should fit the *Titan III*, *Saturn I* and *Saturn I-B* launch vehicles. "Consideration shall also be given to integrating the logistics spacecraft as a component of the launch with a space station using a *Saturn V* vehicle," the center said.

Minimum flight time for the logistics vehicle was put at 48 hours, with rendezvous to be accomplished from either Earth orbit or direct ascent. The logistics vehicle should be able to operate after six months' storage in the space station hanger or in parked orbit nearby.

Suited to either land or water landings, the spacecraft should provide the crew and passengers with a seven-day survival capability after landing. Primary control of the spacecraft will be the crew's responsibility, and on-board propulsion should permit mission abort at any point in the flight.

Shielding from radiation should allow the crew to safely perform two mission cycles a year without experiencing maximum permissible exposure.

The center directed contractors to "explore every possibility of adapting government-funded *Apollo* command and service modules" for the vehicle.

Solid and liquid cargo amounting to 10,000 lbs. would be carried by the spacecraft. The main cargo compartment—to be in the area formed by the launch vehicle adapter, the fairing, and the service module—is to be jettisoned on re-entry. Cargo for return to Earth would be carried in the command module with the crew.

The center advised contractors to consider that the number of persons in the station will be dependent upon the operations requirements, scientific objectives, and crew-rotation cycle. ■

Program Definition Awards Due for Medium-Altitude ComSat

AWARD of program definition contracts for the Defense Dept.'s medium-altitude communications satellite system is expected within the next few days, according to the director of the Defense Communications Agency.

Gen. A. D. Starbird told the House Committee on Government Operations last week that the R&D program for the system probably would involve launching 10 boosters, each carrying clusters of five or more satellites. With a 50% launch success rate or better, this would mean that 25 of the polar-orbit, 5000-10,000-mile-high satellites would be in orbit at any given time.

Present figures indicate that each satellite successfully launched will have a lifetime of three years or longer. The R&D program will total $250 million, Starbird said, with each booster and payload of five or more satellites costing about $10 million.

Although the satellites probably will be launched five to a nose cone, industry proposals have called for from six to as many as nine in a package, according to Starbird.

• **Growing need**—The satellites will be used for command and control for the military on a world-wide basis, but they will not take the bulk of ordinary communications burdens from the commercial carriers, DCA officials say. Military requirements have been increasing by about 10% in each of the past several years, they report.

Once all the satellites in the R&D program are in orbit, it will cost about $25 million a year to operate and maintain the operational system. This will include replenishment of the supply of satellites.

DCA officials also indicate that they have not abandoned the idea of synchronous satellites—though *Advent* is dead, except for one parts reliability contract with GE. They predict that eventually the best communications system may be one in which synchronous, high-altitude, and medium-altitude satellites all are deployed.

The GE contract, which terminates this fiscal year, is for work that can be applied to almost any satellite system, the spokesmen say.

Astronauts May Include Scientists

Official says stepped-up selection schedule reflects new look at Apollo needs; MA-9 will cross and recross China

NASA selection of another new group of astronauts is expected late this year or early in 1964.

It is also indicated that, for the first time, NASA will add scientists to the group—if the test pilot experience requirement is filled.

A space agency official said that the action was necessitated by a new look at the requirements of Project *Apollo* for pilot training. Previously, NASA said that it would select the additional astronauts much later in the *Apollo* timetable.

Currently, there are 17 astronauts actively engaged in the manned spaceflight program. Officials originally indicated that a total of 25 would be needed, but this may be increased.

A Manned Spacecraft Center spokesman declared last week that the agency is studying the possible addition of scientists to the group. He added, however, that scientists would be used only for missions following the first manned lunar landing.

"There are no plans to include a scientist as such in the first lunar landing crew," he said.

Addition of scientists to the group of astronauts could be considered a move to placate dissident scientific groups that have criticized the manned spaceflight program. The inclusion of one of their own among the pilot group could alleviate some of their opposition.

In another manned spaceflight development, Robert R. Gilruth, MSC director, declared last week in Dallas, Tex., that the *MA-9* flight still is scheduled for May 14, but that slippage to May 21 is possible.

Gilruth said the exact date for the launch will depend on a solution of current problems in the *Atlas* booster's inverter and gyroscopes.

The booster had tankage problems earlier, but a NASA spokesman said that difficulty was "all but cleared up."

Cooper's flight—intended to be the longest ever attempted by an American—already is far behind schedule. Originally scheduled for February, the launch date slipped to April and then to May.

Earlier technical problems ranged from a lack of funds to a decision to rewire the *Atlas's* flight-control unit.

The *Atlas* arrived at Cape Canaveral and was mounted on the pad last month. The *Mercury* capsule was placed on the booster last week.

Decision to drop the deep-pressurization experiment from *MA-9* was also announced by Gilruth. Earlier plans called for Cooper to decompress his spacecraft during the flight, allowing him to sample the space environment, protected only by his spacesuit.

Officials decided to drop the test because they said it would take up too much of the astronaut's time.

- **Over Red China**—A detailed flight plan for *MA-9* revealed that Cooper could spend nearly 45 minutes over Communist China during his *Mercury-Atlas* flight.

The first crossing of Chinese territory comes about 10 hours and 20 minutes after launch—during the seventh orbit. The flight path crosses China and Tibet seven times, for periods ranging from four to eight minutes on the seventh, eleventh and twenty-second orbits.

A twenty-third orbit path, for emergency use, would bring the astronaut down in the Pacific near Hawaii.

"Go/No-Go" landing areas have been set up in the Atlantic, east of Bermuda, for the second, sixteenth and seventeenth orbits. Similar landing areas—southeast of Midway Island in the Pacific—are prepared for the seventh and twenty-second orbits.

Planned landing areas in the Pacific lie west of Johnston Island on orbits three, eight and eighteen; northeast of Midway (above 30° north latitude) for orbits five, six, twenty and twenty-one. A ninth-orbit landing area lies south of Osaka, Japan; and the preferred emergency landing area on orbit number ten lies east of Taipei. If an emergency is called on the eleventh go-around, the preferred landing area is east of the Philippines, (at 10° north latitude).

In the Atlantic, the planned landing area for orbit thirteen is off the Canary Islands. The recovery area for orbits three and eighteen lies east of Canaveral.

The command ship Coastal Sentry will be stationed south of Japan, among the islands (at 130° east and 29° north).

The Canton island ship's position lies just below the equator in the Pacific (at 176° west).

Rose Knot Victory will be in the South Pacific, west of Easter Island (120° west and 23° south).

Cooper will be beyond the indicated range of the tracking network for most of orbits four and nineteen, five and twenty, six and twenty-one.

The retrofire point for orbits seven and twenty-two lies just off the China coast, southeast of Shanghai. ■

Arc Jet Engine Runs for Thirty Days

AN ELECTRIC arc jet space engine has just completed a 30-day run at Avco Corporation's Research and Advanced Development Division, Wilmington, Mass.

The 720-hour operation, by far the longest run of any electric space propulsion engine, was a qualification test run for NASA's Lewis Research Center.

Such engines would be used to power spacecraft on a long flight.

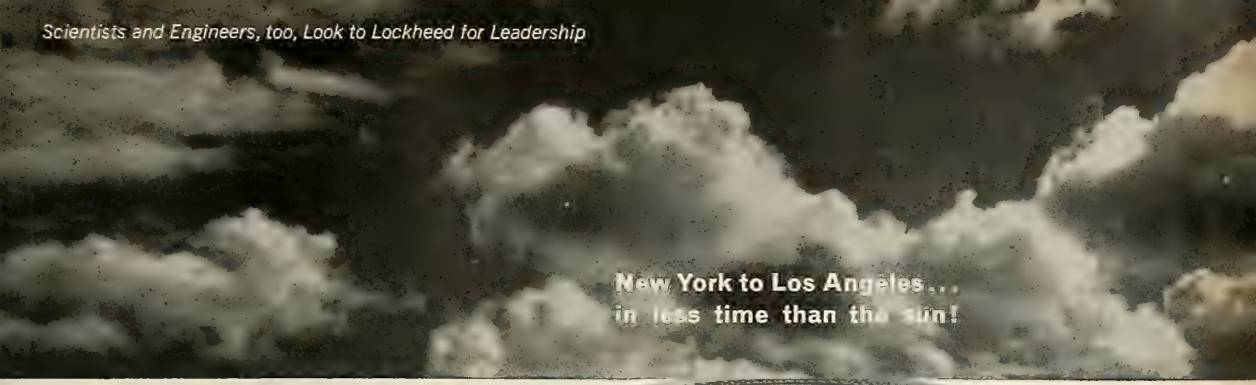
Dr. Richard R. John, manager of the firm's Arc Sciences Laboratory, said the long qualification test under simulated space conditions was a success from every standpoint.

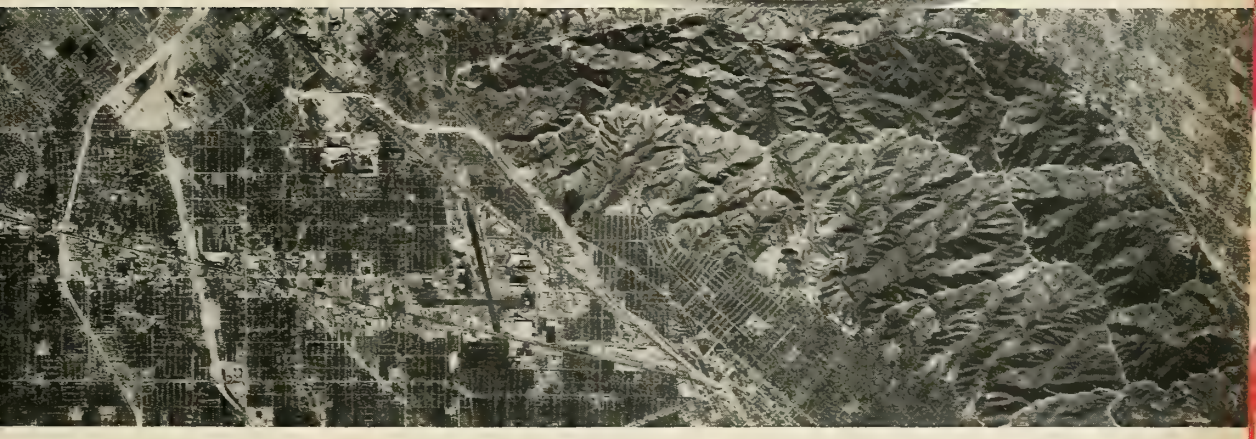
"The engine's continuous operation was interrupted only twice," he stated, "Once, after 250 hours, at the request of NASA, to check out the thrust stand, and once, unintentionally, due to a brief municipal power supply failure." After each shutdown, the engine was restarted without dissembling the engine or its systems. No adjustments were necessary.

Dr. John declared that there was no significant deterioration of the electrodes, constrictor chamber or nozzle of the 30-kw engine, indicating that the engine could have run for a much longer period of time.

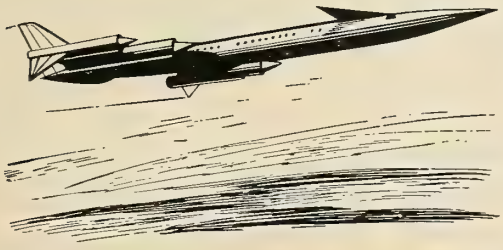
"The success of this test strongly indicates that engine operation in the megawatt power range is feasible," he stated. He said that, "operation of high-power versions of the engine with MHD thrust augmentors at specific impulse up to 3000 seconds appears within reach."

Scientists and Engineers, too, Look to Lockheed for Leadership





TIME SQUEEZE



Time: ***NOON***

Place: ***NEW YORK INTERNATIONAL AIRPORT***

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Time: ***11 AM (Same Day)***

Place: ***LOS ANGELES INTERNATIONAL AIRPORT***

Out of the eastern sky the plane descends in a long glide, its engines muted, its wings still hot from the Mach 3 speed which outpaced the sun for 2,469 miles. Result? Time is squeezed until it runs backward and the plane arrives *before* it departs—less than two hours out of New York.

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How to get someplace by going around in circles

The rotating Space Station Simulator shown here is only one of the many new facilities increasing Grumman's capabilities in the space field. Administered by Grumman's Space Sciences and Human Factors Group, the Simulator is yielding valuable information on the factors that affect man's tolerance of rotation. A program of continuing tests will help show how astronauts can live and perform in an artificial gravity environment. ■ Bioscience is just one facet of Grumman's expanding space studies, which include such basic disciplines as orbital mechanics, propulsion, guidance, structures, and reentry dynamics. Grumman is integrating and applying these disciplines into such long-range NASA programs as the OAO for Goddard Space Flight Center, and the LEM for the Manned Space Flight Center.

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Where Advanced Ideas Grow Into Reality

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One answer to man's survival in space travel is a rotating space station which would roughly simulate gravity conditions. To study the effect on humans of the Coriolis and gyroscopic coupling forces which attend such rotation, Grumman has adapted the company's giant centrifuge as a rotating Space Station Simulator. Experiments in this room are monitored by movie camera, from which these photos were taken. This equipment is also valuable for sustained acceleration testing of unmanned space vehicles and components.



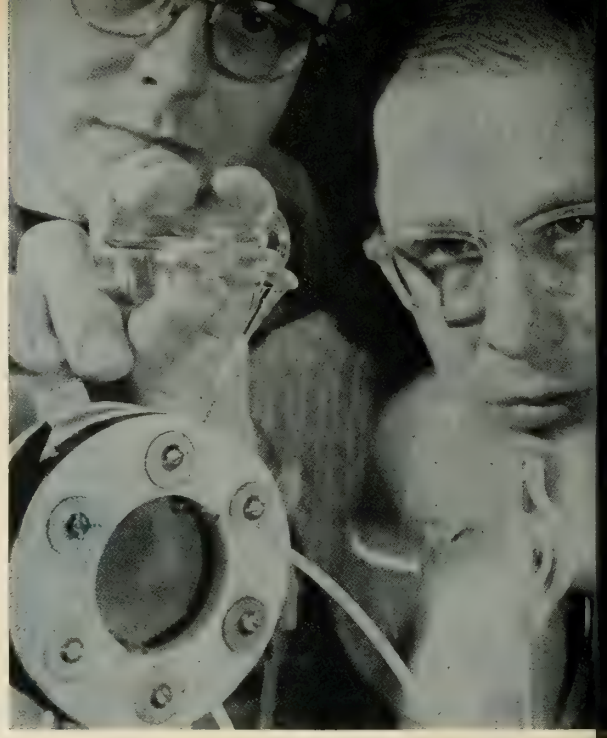
Engineers and Scientists . . . up-to-the minute facilities speed professional growth. See Grumman's ad on page 64, for immediate career opportunities.

Ten years hence . . .

Hydrocarbon Fuel Cells May Power Tracking Sites

General Electric demonstrates for first time an operating, low-temperature cell which offers many novel advantages

by William Beller



DIESEL oil combines with air in fuel cell to power motor.

NEW YORK—Hydrocarbon fuel cells within a decade may generate primary power for remote missile and tracking sites, and standby power for bases fed by commercial power stations.

This was predicted last week by Dr. Guy Suits, as he demonstrated publicly for the first time an operating, low-temperature, hydrocarbon fuel cell. Suits is vice president and director of research of General Electric Co., developer of the device.

Chief advantage of such a cell is that its fuel is cheaply obtained, easily stored and shipped—an advantage not shared by the commonly known hydrogen-oxygen fuel cell.

Other advantages fuel cells have over competitors:

—Efficient conversion of fuel to electricity.

—Reliability because of no moving parts.

—Noiseless operation.

—No electromagnetic signal.

Until last week, it was not generally known that a low-temperature, hydrocarbon fuel cell could be made. It was known, though, that GE is currently assembling a hydrogen-oxygen fuel cell to generate about 2 kw for the *Gemini* capsule.

Last December, the company disclosed a high-temperature, hydrocarbon fuel cell operating between 1000° and 2000°F.

To get a cell to operate at around 300°F, however, was generally considered to be beyond the state of the art.

In last week's demonstration, diesel oil as well as cetane and n-octane (straight-chain relatives of gasoline and diesel oil) were combined in fuel cells with air to drive small electric motors. The operating temperature was between 250° and 400°F and the pressure was atmospheric. The experimenters pointed out that they had also successfully used propane and natural gas as fuels.

● **Many uses**—Because of its potential military value, the hydrocarbon fuel cell has received substantial support from the Advanced Research Projects Agency (ARPA), and the U.S. Army Mobility Command through its Engineer Research and Development Laboratories (ERDL), Fort Belvoir, Va.

The hydrocarbon fuel cell, more rugged than most other power-generating devices and far less thirsty for fuel, could lend itself to a wide range of military uses. Among these, says Walter C. O'Connell, manager of GE's direct energy conversion operation:

—Portable power units for communications and surveillance.

—Mobile electrical power sources.

—Relays and beacons.

—Heating and cooling of all-weather suits.

—Power for missile sites.

—Military vehicle power, using electric drives.

● **A notable accomplishment**—From a scientific viewpoint, "the most remarkable facts about the new cell are that measurements indicate 100% oxidation of straight-chain hydrocarbon fuels," said Suits. This means that the hydrocarbon's reaction with the oxygen from the air went all the way to carbon dioxide and water. As a result, the fuel cell could be used inside a closed building and would deliver no noxious exhaust to the occupants. This, of course, is not true of the internal combustion engine.

Suits added that good performance had been achieved from a large number of hydrocarbons—in gaseous, vapor or liquid conditions. Chemically speaking, he said, "this means that (GE chemists) Drs. Thomas Grubb and Leonard W. Niedrach have solved several of the most difficult problems in the area of fuel-cell research."

The practical efficiency of the fuel cell is between 50% and 70%; for the conventional motor-generator set, the efficiency is between 10% and 40%. Efficiency defined here is electrical-power-out/heat-of-combustion-of-fuel.

These figures indicate that a fuel cell can put out a given amount of power with only about half the fuel needed by more conventional generators.

O'Connell stated that the hydrocarbon fuel cell is today at the same state of the art as the hydrogen fuel cell was four years ago. Then, the hydrogen fuel cell put out 0.5 kw/ft^2; today, the figure is up to 3 kw/ft^2.

The biggest problem in devising low-temperature, hydrocarbon fuel cells is



SURE, IT'S A TEAKETTLE. BOILS WATER. BUT IT ALSO DISSIPATES THE HEAT BENEATH IT, BY BLOWING OFF STEAM. ☐ AT UTC, WE APPLY THIS "BOIL-OFF" PRINCIPLE TO COOL LIQUID-PROPELLANT ROCKET MOTORS. WE MAKE THE THRUST CHAMBER OF OUR NEW EPOXY-BONDED, FILAMENT-WOUND MOTOR FROM A TOUGH, ABLATIVE MATERIAL THAT LITERALLY BOILS AWAY UNDER EXTREME HEAT, THEREBY PROTECTING THE THRUST CHAMBER AND NOZZLE. ☐ RESULT: A LOW-COST, RELIABLE MOTOR THAT AVOIDS THE PERFORMANCE PENALTIES OF REGENERATIVE COOLING SYSTEMS, YET GUARANTEES 10 MINUTES OPERATION. THRUST LEVELS FROM 50 TO TENS OF THOUSANDS OF POUNDS. A STATE-OF-THE-ART DEVELOPMENT FROM UTC.

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U A

Circle No. 16 on Subscriber Service Card

The mighty struggle for the sea

One phase of Hughes pioneering work in underwater visibility—where the effects of various conditions on closed circuit TV are gathered first hand.

How far can TV "see" underwater? How does sound behave in the sea? Are there unexploited new techniques which could be useful in this hostile environment? These are questions which are being answered by Hughes engineers and scientists aboard oceanographic ships and at land facilities.

Each answer is a vital link in a massive struggle — to know the sea is to control it. And while we know a great deal about the atmosphere and space beyond — we know less about the sea even though it holds much greater potential usefulness.

One of Hughes most important activities is in Sonar — Sound Navigation and Ranging — presently man's most effective tool in undersea defense and exploration.

For example, as submarines have become more capable — diving deeper, running farther and faster — we are obliged to develop more effective means of detection, classification and localization. Working with the U. S. Navy, Hughes scientists and engineers are engaged in all aspects of research, development, production and installation of sonar systems. They are being developed for surface vessels, submarines, aircraft and for the ocean's floor.

Some specific programs include submarine-radiation measurements, analytical and acoustical testing, classification and methodology studies, and the development of





The 100-foot Tilman J oceanographic vessel is one of two research ships docked near Hughes plants — just minutes from deep water. Fully instrumented for military and commercial work, it has a 5,000-mile range.

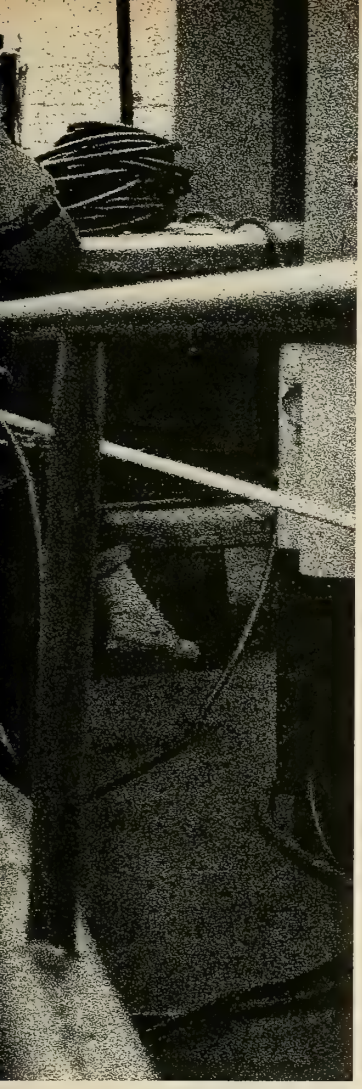
MOBOT* is lowered into one of the two test tanks maintained by Hughes for underwater research. This 105,000-gallon tank is one of the largest facilities for acoustic transducer tests and noise field measurement studies.

*Trademark Hughes Aircraft Company

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

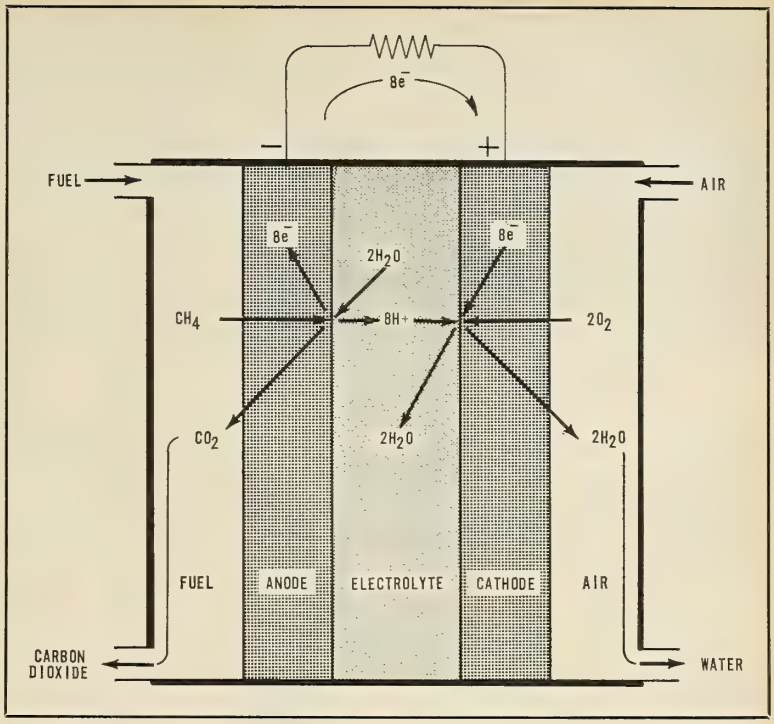


ansducers, acoustic array systems, high ain receivers, sonobuoy systems, helicopter nar and advanced data processing and splay systems.

ther Hughes programs, undertaken in co- peration with major oil companies and her groups, include the remote-controlled OBOT* systems and new varieties of dy- amic ship positioning devices. MOBOT* today working the ocean's depths—devel- oing oil fields and other permanent sea or installations.

ese activities, and others, owe their useful- ss to a Hughes belief that the only way to derstand the sea is to work with it. That w ideas and new equipment can prove eir mettle only when subjected realisti- lly to the rigors of the ocean environment.

ngineers and scientists with abilities and terest related to these or other Hughes ograms in advanced electronics and space e invited to inquire. Hughes is an equal portunity employer. Please address Mr. L. Gillespie, Manager Employment and anpower, Hughes Aircraft Company, ulver City 29, California.



SCHEMATIC of new hydrocarbon fuel cell illustrates the reactions with methane.

to get the saturated hydrocarbons to react. They are considered so inert they are called "paraffins."

The solution, reported Grubb, is to use specially constructed platinum electrodes plus a phosphoric acid electrolyte. He said that with such a technique, power densities have been achieved up to 25 watts/sq. ft.—50 amps at 0.5 volts. Most gratifying, though, was the fact that the operating temperatures were between 300°F and 400°F. In the practical device, these temperatures would be obtained from the unit's waste heat.

An urgent problem, however, is to reduce the high cost of the platinum electrodes. This may be done by going to electrodes of different materials.

● **Operating with methane**—A fuel cell is an electrochemical device that continuously converts the chemical energy of a fuel and oxygen directly to electrical energy.

The schematic of GE's new hydrocarbon fuel cell assumes an acid electrolyte. Methane (CH_4), the major constitutent of natural gas, is used to typify the series of saturated hydrocarbons being considered as fuels.

The fuel is fed to the anode side of the cell. At the anode, the methane molecule loses electrons and combines with water originally present in the liquid electrolyte. Carbon dioside forms and is rejected from the cell. The remaining hydrogen atoms from the fuel are released to the electrolyte as hydrogen ions.

The electrons are conducted out of the cell to do work. The hydrogen ions are conducted through the electrolyte to the cathode.

Air is fed to the cathode side of the cell. Here, the returning electrons combine with oxygen and hydrogen ions to form water. This water more than balances the amount lost in the reaction at the anode. Excess water is rejected from the cell.

The overall reactions occurring at each electrode are:

Anode:

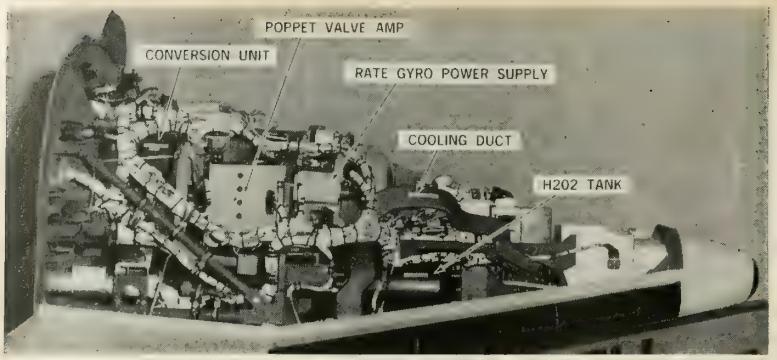
$$CH_4 + 2H_2O \rightarrow CO_2 + 8H^+ + 8e^-$$

Cathode:

$$8e^- + 8H^+ + 2O_2 \rightarrow 4H_2O$$

● **The fuel battery**—Under rated operating conditions, fuel cells usually produce less than one volt per cell. (Their usual operating point is between 0.50 and 0.85 volts.) To provide six volts, said a GE spokesman, seven to twelve cells are stacked in series. For 12 volts, 14 to 24 cells are stacked together, and so on. To provide the required power, these stacks are then wired in parallel.

Current is dependent on the active areas of the cell—usually described in terms of milliamps per square centimeter or amps per sq. ft. (For rough calculations, these are directly convertible: 50 ma/cm² is roughly equivalent to 50 amp/ft².) ■



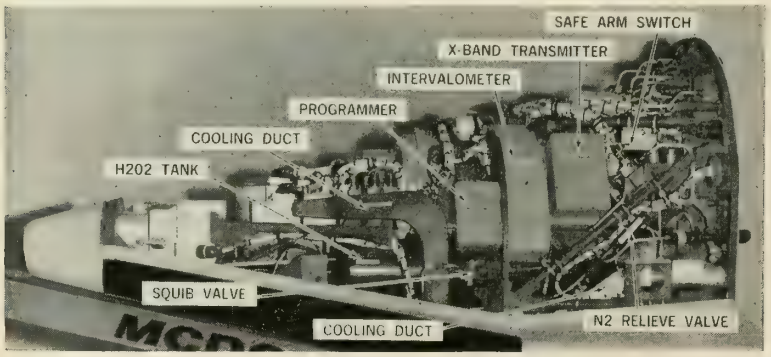
ASSET Vehicles To Fill Part of Dyna-Soar Gap

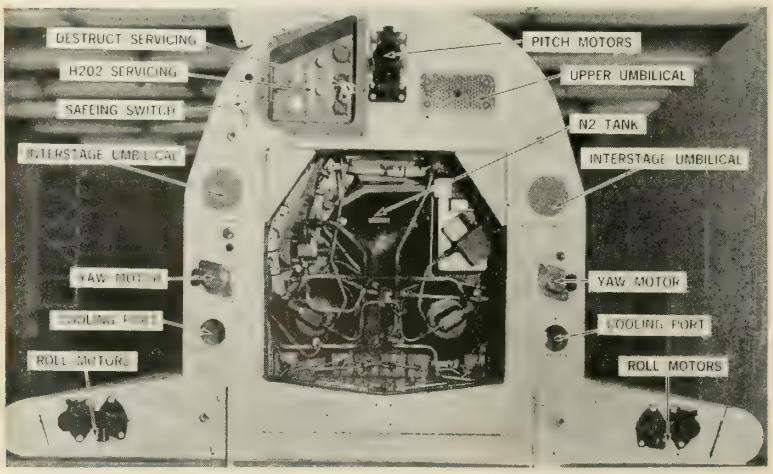
THE AIR FORCE may get a sizeable portion of the information it expected from *Dyna-Soar* at only 5% of the overall cost.

Two versions of the *ASSET* vehicle (Aerothermodynamic/elastic Structural Systems Environmental Tests) will explore the re-entry corridor at velocities up to Mach 18 and altitudes of 230,000 ft., thus filling a part of the gap left by the *Dyna-Soar* cutback.

Total cost of the program thus far has been about $13 million, compared with the $200-million-plus anticipated cost of the *Dyna-Soar (X-20)* program. A program spokesman emphasized that *ASSET* is not a replacement for the *X-20*, but said it will provide much of the same information in the region of Mach 12 to 18 and below.

"The *X-20* tragedy is wrapped up in the fact that no booster was available in 1959 to push into orbit a monstrous structure 60% of whose weight and volume was assigned to 4% of its mission," he said. "There are undoubtedly some good reasons for continuing the *X-20*, but one of them is not that it is an economically feasible way of getting test results necessary for the advancement of lifting re-entry vehicle technology."



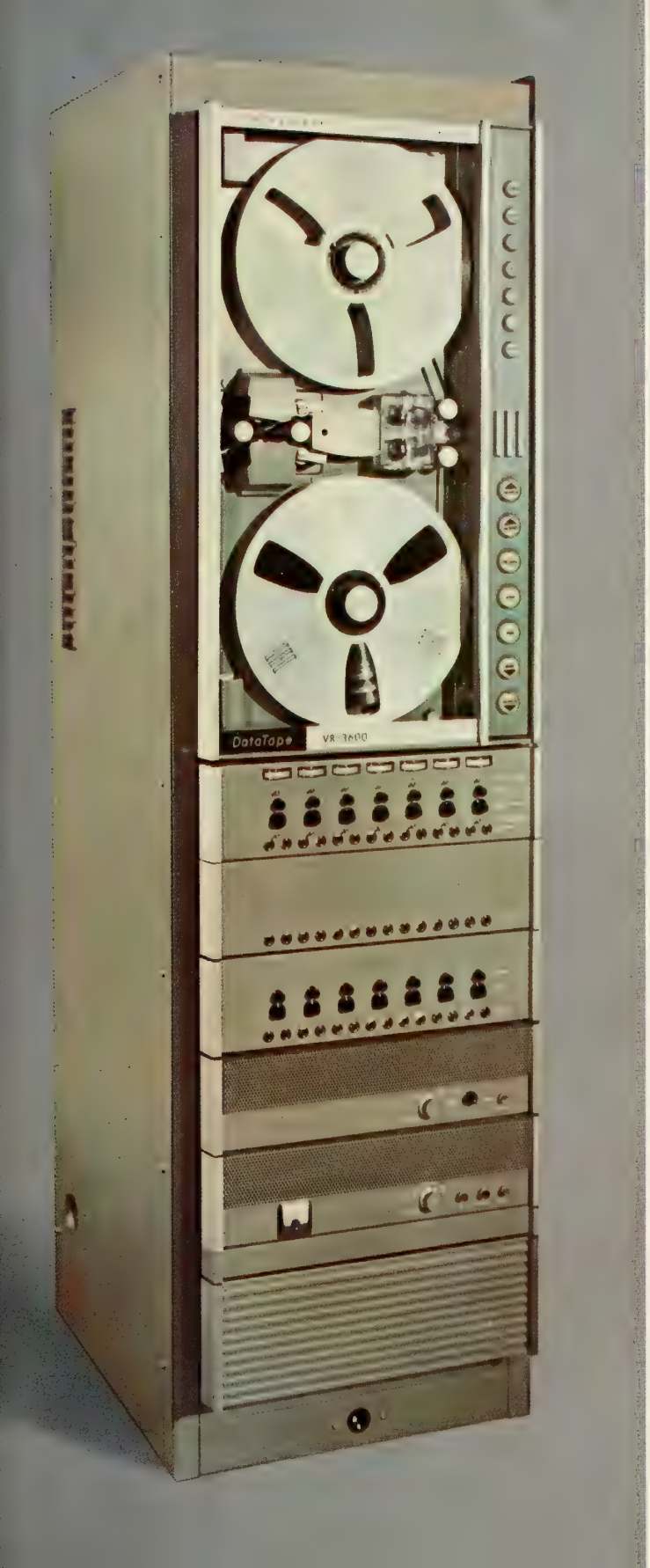


● **Summer shot**—Plans call for the first test flight of *ASSET* aboard a *Thor* launch vehicle to take place late this summer at the Atlantic Missile Range. One version, the aerothermodynamic structural model (shown in accompanying photos), will use the *Thor-Delta* booster; the aerothermoelastic model will use only the *Thor*. The former weighs 1100 lbs., and the latter weighs 1200 lbs.

Six vehicles are in the overall program: four aerothermodynamic structural models and two aerothermoelastic models, with the former designed to investigate various structural concepts and obtain free-flight data on materials, coatings, surface temperatures and pressure distributions. The two aerothermoelastic models will investigate thermal effects on structural response and aeroelastic instabilities. McDonnell Aircraft Corp. is prime contractor for *ASSET*.

Both models of the *ASSET* vehicle are the same size—68.7 in. long, 58.9 in. in span, 14 sq. ft. of wing area—and fabricated of titanium, aluminum and beryllium. Both will use a Minneapolis-Honeywell guidance system, with pitch attitude established by the location of the center of gravity in each vehicle and reaction jets providing pitch damping. Reaction jets will also provide roll and yaw control, since the vehicles have no movable control surfaces. In overall appearance, the vehicle is a dead-ringer for the *X-20*.

The aerothermodynamic structural model will be boosted to between 195,000 and 230,000 ft., then glide for 2000 mi. at peak velocity of Mach 18, taking 17 minutes for the trip. The aerothermoelastic model will start its glide at about 165,000 ft. and glide at peak velocities of Mach 12 for 1000 mi., taking 10 minutes to make the trip. Recovery will be by parachute, and range ships are expected to retrieve the payloads. Nose cap temperatures are expected to reach over 4000°F. ■



The first 1.5 MC recorder delivered.

CEC's VR-3600... Highest performance in the industry.

FEATURES

- 1.5 MC Direct Frequency Response
- Linear Phase Vs Frequency Characteristics
- 7-or 14-Channel Record/Reproduce
- Vacuum/Ionization Tape Cleaner
- Utilizes RFI Design Techniques

CEC's VR-3600 Magnetic Tape Recorder/Reproducer has proven its outstanding capability by outperforming all comparable instrumentation in the extremely wide bandwidth, multi-channel field—*with units built and delivered in quantity*. And it's the *first* 1.5 mc recorder sold to *working* specifications. This means specs that are practical from the *users* viewpoint—all met with one set-up of the tape system, not with separate adjustments before each test.

Each of the VR-3600's channels can be used for data storage in the 100 kc to 1.5 mc frequency range—with high signal-to-noise and low distortion characteristics.

The direct system has a full 1.4 mc bandwidth fully amplitude and phase equalized, with less than 2% harmonic distortion. No intermodulation product exceeds 0.75%, and phase response is held to within 0.2 usec.

In the tape transport, skew is under —.30 usec., flutter is less than 0.30% p-p at 120 ips, tape is constantly cleaned by a vacuum/ionization device and tension is held smoothly constant by a closed-loop servo.

For *all* specifications, contact your local CEC sales representative, or write for Bulletin 3600-S.

CEC Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of **Bell & Howell** • Pasadena, California

6 ways CEC reflects the "state-of-the-art" in recording

Wherever they're found — in laboratory, fixed base, mobile, shipboard, or blockhouse applications — you can be sure CEC recorder/reproducers represent today's most advanced products in the tape field. All incorporate the accuracy and reliability inherent in all CEC instrumentation . . . prime reason for their success in applications involving the nation's most advanced missile/space programs. Below are 6 recorders in the CEC line that makes the company a single source for virtually all needs in the magnetic tape field.



PR-3300 combines low cost and portability with excellent performance. The complete 14-channel record and reproduce system can be unitized as a single portable system 29⅞ inches high weighing no more than 213 pounds. Direct, FM, or PDM techniques can be used singly or combined. CEC Bulletin 3300S.



VR-3300 is a wide band system for use in applications where portability is desirable. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques — or twice the bandwidth of standard telemetry records. Features include 6 speeds and all solid state electronics. Bulletin 3300VS.



DR-2700 is a high speed Vacuum-Buffered Digital Magnetic Tape System designed for on-line and off-line digital computer usage. A complete 16-channel digital write and read system can be housed in the unit's 72-inch-high RETMA cabinet. Outstanding reliability has been proven in critical military applications and in IBM compatible installations. Bulletin 2700S.



GR-2800 is solid state, a fully integrated recorder/reproducer system. A single standard 19-inch EMA rack with a 64-inch-high opening contains the complete 14-channel record and reproduce system. The one cabinet can mount 28 amplifiers (operating in Direct, FM or PDM modes), capstan power amplifier, and tape-speed control servo. Direct record response is 100 cps to 100 kc; FM response is 0-10 kc. Bulletin 2800S.



VR-2600 is an advanced design, multi channel wide band data recording and reproducing system designed to handle precision data in the frequency spectrum from d-c to 600 kc. Record and playback amplifiers in the 14-channel system can handle Direct, FM, and PDM data. 16 track PCM techniques can also be supplied. Bulletin 2600S.



VR-2800 is a wide band system for use in laboratory environments with Direct and FM electronics. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques. The full 7- or 14-channel system, with 6 speed operation and plug-in electronics, can be packaged in a single, six-foot EMA cabinet. Bulletin 2800VS.

CEC Data Recorders Division
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Technical Countdown

ASTRONAUTICS

Proton Shower Forecasts 100% Reliable

Solar-flare predictions by the Air Force so far have been 100% reliable, according to an AF Cambridge Research Laboratories spokesman. As the "art" now stands, he said, scientists can forecast the safe periods but are unable to predict actual occurrences of solar storms. For manned spaceflights, the best forecasts now involve only a five-day safe period. It was pointed out that the unusually high reliability attained so far may be related to the current decreased storm activity on the Sun. Currently, one out of four solar flares produces proton showers, which usually occur 20 to 30 days after the start of an eruption.

Miniaturized Space Microscope Shown

A miniaturized microscope, small and light enough for use in space probes, has been demonstrated on closed-circuit TV to the Royal Microscopical Society. Designed by Dr. J. N. MacArthur and demonstrated by Dr. F. L. Jackson, in collaboration with the Kalee Division of the Rank Organization, the microscope has remote focusing and control facilities. A method also has been developed by the scientists for picking up samples: sticky tape containing nutrients would be fired from the capsule and then reeled back under the microscope lens.

Two UK Satellite Cameras Developed

The Royal Radar Establishment (Ministry of Aviation), Malvern, Worcestershire, has designed and constructed the most powerful satellite-tracking cameras yet available in Britain. They are two 24-in.-focus, f/1 Schmidt cameras, each weighing 8½ tons, capable of tracking orbiting vehicles with an accuracy of one second of arc. The optical system includes a 32-in.-dia. spherical mirror with a simple 25½-in.-dia. Schmidt plate. In addition, a three-element lens about 0.5 in. in front of the photographic plate is used to bring the image into a flat field instead of the spherical one normally associated with a Schmidt. The optical system has a field of 10° and is achromatized between 4800 and 6000 Angstroms.

ELECTRONICS

Pop-Up Antenna From General Dynamics

A hardened pop-up antenna concept, designed to withstand nuclear attack, is being perfected by General Dynamics/Electronics in conjunction with Chu Associates. The antennas would be mounted in protective underground silos. In the retracted position, the units would be safe from nearby nuclear detonations, ready to resume communications links after the attack. General Electric is prime contractor to the Air Force for a similar pop-up system already being delivered for installation at three *Titan II* bases (M/R, March 11, p. 18).

Scale-Model Antennas Cut Time and Costs

Photo-etched holes on a copper-clad dielectric dish are being employed in an anechoic tunnel by Electronic Communications, Inc., as a new technique for scale-modeling antenna arrays. According to ECI scientists, a plane wave incident on one side of such a "holey" plate emerges from the other side in a manner essentially equivalent to that of a full-size antenna. The approach vastly reduces the normal fabrication problems associated with test arrays and minimizes supporting theoretical computation. The novel models have been used for pattern measurement of array apertures with beamwidths of less than one degree. One ECI 8-in.-aperture model operating at 70 gc is equivalent to a 39-ft.-dia. array designed for 1.2-gc operation.

Sonar Missile-Impact-Location Data Studied

The Air Force is evaluating data acquired during test runs of equipment on Project STAR (Ship-Tended Acoustic Relay). The system utilizes a ship equipped with sonar to pick up signals broadcast by underwater equipment in missile-impact areas. The submerged equipment consists of a hydrophone suspended by cable from a buoy and a transducer-battery-anchor combination on the bottom of the ocean. Vibrations generated by a Sofar bomb on missile impact are acquired by the hydrophone and relayed to the transducer, which broadcasts a signal. Precise positioning of a series of hydrophones permits extremely accurate measurement of the impact point.

NASA Buys Large-Memory Computer

A Burroughs B-5000 computer has been added to Marshall Space Flight Center's Computation Division for use in automating data reduction processes. The digital computer is one of the largest at MSFC and has a 32,000-word memory of 48 bits per word. This gives the B-5000 a larger memory capacity than any other computer at the center. In practice, data will be fed directly to the computer, where it will be reduced automatically to a usable form.

ADVANCED MATERIALS

New Crystal Vibration Phenomenon Discovered

Acoustical vibrations at widely scattered areas within crystals apparently occur and are related to structural defects, say Westinghouse scientists. This is believed to be the first indication of finding direct evidence that crystal vibrations are not necessarily coherent. Quartz crystals were used in the studies. The company claims that the discovery may explain the odd effect of neutron radiation on fused quartz and may help raise operating temperatures of lasers and masers.

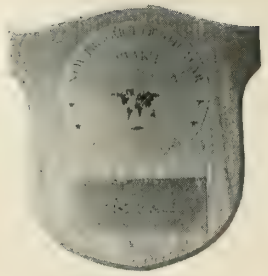
PROPULSION

Four-year MM Rocket Storage-Life Predicted

A *Minuteman* first-stage solid-rocket motor was successfully fired last month after 27 months' simulated storage and a 3000-mi. road test. Static-tested at Thiokol Chemical Corporation's Wasatch Div., Ogden, Utah, the motor was subjected to the longest "storage" period to date. Storage temperature was 70°F±10°; relative humidity was varied from 0-45%. Test data now indicate that such motors should be capable of reliable performance after up to three years of storage, and Thiokol engineers predict that their *Minuteman* first-stage motors will work properly after more than four years in storage.

Soviet Rocket-Testing Report Available Soon

A Russian book on the static- and flight-testing of rockets is scheduled to be published in the second quarter of 1963. It is "Arrapature i Metody Izmerenii pri Ispytaniyakh Raket" by A. V. Kantor. Price: 1 ruble 95 kopeks. Publisher: Onorongiz.



Rocket Research Solid Microrocket Wins Award

M/R's annual prize goes to miniature low-thrust unit; runners-up are National Research, Raytheon and EAI

ROCKET RESEARCH Corporation's Subliming Solid Microrocket has been selected winner of MISSILES AND ROCKETS' Annual "New Product of the Year" Award.

The winning entry, a miniature low-thrust rocket designed for spacecraft attitude control, was selected by the staff of M/R from the 52 "New Product of the Week" features published in the magazine during 1962.

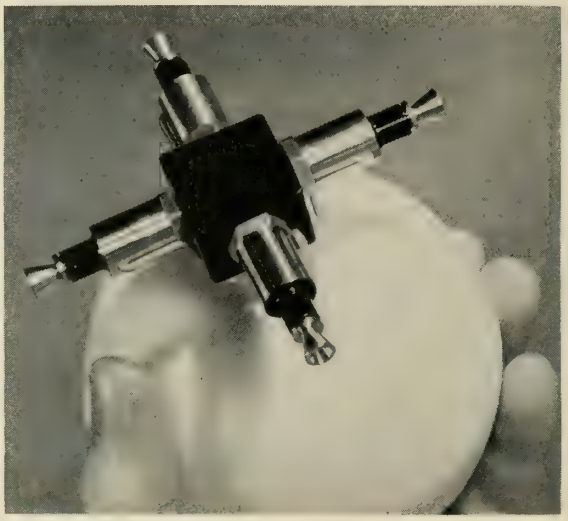
Robert M. Bridgeforth, Jr., Rocket Research chairman of the board, accepted the plaque last week from Wayne W. Parrish, President of American Aviation Publications, Inc., at a ceremony in the Rainier Club of Seattle.

The company, said Mr. Parrish, can be justly proud of its hard-won honor, especially considering the caliber of its competition. Each "New Product of the Week," he pointed out, is carefully selected from the hundreds of new-product announcements received and reviewed weekly by M/R editors.

The Subliming Solid Microrocket is being manufactured by Rocket Research under contract from NASA's Goddard Space Flight Center. Representing NASA at the luncheon were Dr. Joseph V. Fedor, technical director at NASA for Rocket Research's contract, and Richard Forsythe of Dr. Fedor's staff.

Representatives of the aerospace industry and the Air Force, and local civic and university leaders attended the award luncheon.

Three Awards of Honor also were announced last week by Editor William J. Coughlin. Runners-up and their winning New Products were: National Research Corporation, Cambridge, Mass. (Extreme High Vacuum Chamber); Raytheon Company, Waltham, Mass. (Model LG-2 Helium-Neon Laser); and Electronic Associates, Inc., Long Branch, New Jersey (HYDAC-2000, a New Hybrid Digital Analog Computer). Presentation of these plaques will be made individually by Coughlin next month.



PRIZE-winning Subliming Solid Microrocket produced by Rocket Research Corp.

● **Low thrust, long life**—Rocket Research Corp.'s Subliming Solid Microrocket is designed to replace cold-nitrogen-gas attitude-control systems where the total impulse required is low or moderate. Providing thrust levels from 0.001 to 10 lbs., it employs a new type solid propellant, called Sublex, capable of intermittent operation, and bypasses the need for either ignition or combustion. Sublimation of the propellant occurs only when a valve opens, releasing the thrust-producing vapor through the rocket nozzle.

Weighing approximately half as much as a cold-nitrogen system, the tiny four-nozzle rocket is capable of pulsing on and off millions of times over a period of months or years.

The complete system, comprised only of propellant, tank, and valve, weighs 2.7 lbs. loaded and 0.4 lbs. empty. A 4-in. spherical tank contains sufficient propellant to provide one year's control for a 5-ft. satellite.

The control rockets can be used to provide directional orientation and to make vernier corrections.

Most present satellite attitude control systems employ cold nitrogen gas, stored at high pressure, to produce low-pulsed thrust.

Since the Rocket Research propellant is stored in the condensed solid phase, and since low pressures are used (under 10 psia) tanks are small and light. The pressure regulator of the nitrogen system is eliminated.

● **Hi-vac space chamber**—The National Research Corp. space chamber offers a significant advancement in high vacuum technology. By employing a chamber-within-a-chamber design concept and cryogenic pumping techniques, pressures of the order of 10^{-15} torr have been attained by the company.

Existing high-vacuum chambers are capable of simulating conditions in near-space (500-800 miles altitude). NRC's new system provides the first capability of simulating and testing in the interplanetary space vacuum.

The first of a whole family of all-metal space simulation systems, NRC scientists believe, the very same design principles can be employed for the construction of larger chambers—up to several thousand feet, operating at pressures from 10^{-14} to 10^{-16} torr.

● **Laboratory laser**—Raytheon's LG-2 Laser represents the culmination of a concerted effort to make available to the general consumer a gaseous laser suitable for a wide range of laboratory experiments. Measuring 3 in. in dia. x 48 in. long, it weighs only 10 lbs.

The helium-neon laser offers several principal advantages:

—Output at 0.63, 1.15 microns and other wavelengths up to more than 3 microns. (The visible red line is of special practical advantage.)

—Availability with Brewster tube or external reflectors. Use of the Brewster tube gives linear polarized output, (important for modulation experiments). The LG-2's output can be modulated by the Zeeman effect, which rotates the plane of polarization.

—Portability during operation. Withstands acceleration, vibration and shock of more than 1 G in any direction without losing single-mode operation.

—Lifetime of the tubes warranted for more than 1000 hrs., but life expectancy exceeding one year because of the use of ultra-high-vacuum filling methods and getters in the tube.

—Full electrical shielding against RF radiation. Magnetic shielding is available.

—Precision adjustment of the cavity length (for pure single-mode operation) accomplished by one single screw without disturbing the angular adustment of the reflectors. Thus, a bandwidth of less than 10 cps single-mode is possible.

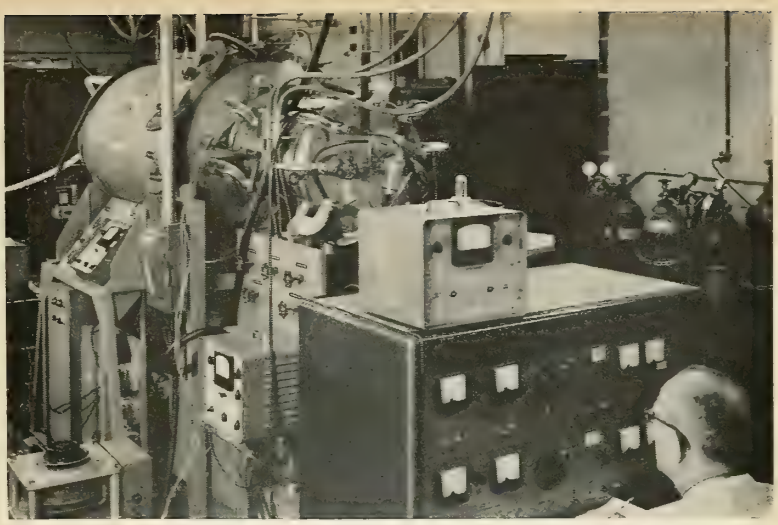
—Beam divergence, beam diameter and power for multiple mode operation: 10 minutes of arc, 8 mm, 1.5 to 2 milliwatt; for single mode operation: 3 minutes of arc, 0.5 mm and 0.1 milliwatt.

● **Analog/digital system**—The HYDAC 2000 Hybrid Digital Analog Computer was developed by Electronic Associates, Inc., to fill a void in existing analog and digital computers for the solution of many aero-space engineering problems.

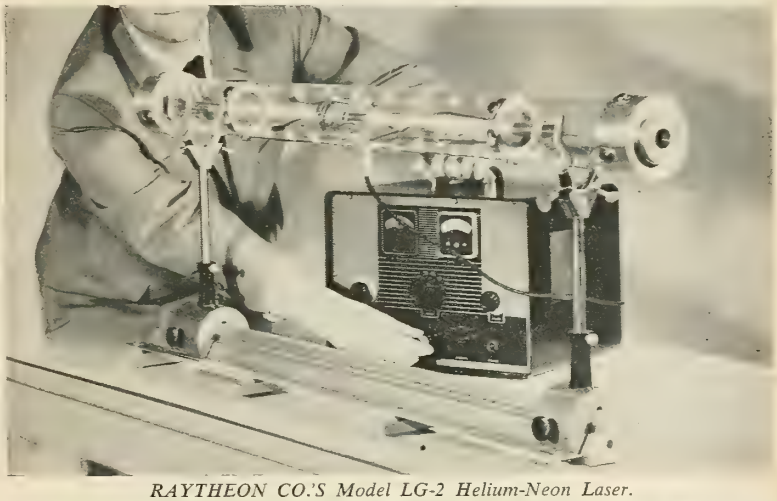
The Hydac 2000, developers say, represents a blending of analog and digital building blocks into an integrated system. To accomplish the primary function of computation, analog and digital computing and storage elements are available in the relative quantities required to suit the specific problem. The system in effect includes a number of individual analog and digital computers. For communication between individual computing elements, control and data translation or conversion channels are provided.

A programmable system of logic building blocks serve as master control of the entire hybrid computer. Maximum flexibility is achieved through prepatch panel programming of the computation, translation and logic building blocks.

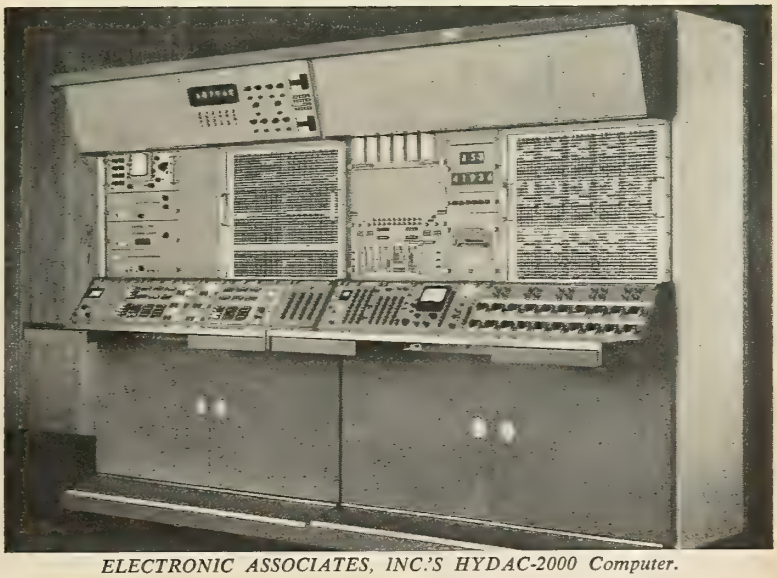
The Hydac 2000 is believed to be the first true hybrid computer to permit analog and digital operations by one integrated computing system, and the only computer to permit real-time simulation of hybrid systems. ■



NATIONAL RESEARCH CORP.'S Extreme High Vacuum Chamber



RAYTHEON CO.'S Model LG-2 Helium-Neon Laser.



ELECTRONIC ASSOCIATES, INC.'S HYDAC-2000 Computer.



It is the Northrop F-5.

It is the plane selected by the U.S. Department of Defense for deployment to our allies in the Military Assistance Program.

There are some good reasons why the F-5 was chosen.

For one thing, it can do many different jobs. It c operate as an air-to-air fighter, a close support w pon, an attack fighter/bomber, or a reconnaissa aircraft.

It can carry 6,200 pounds of payload. Bombs, r siles, napalm, rockets, or extra fuel. Yet the F

America's allies will soon have

a new fighter,

a new ground support weapon,

a new missile launcher,

a new reconnaissance plane,

a new bomber.

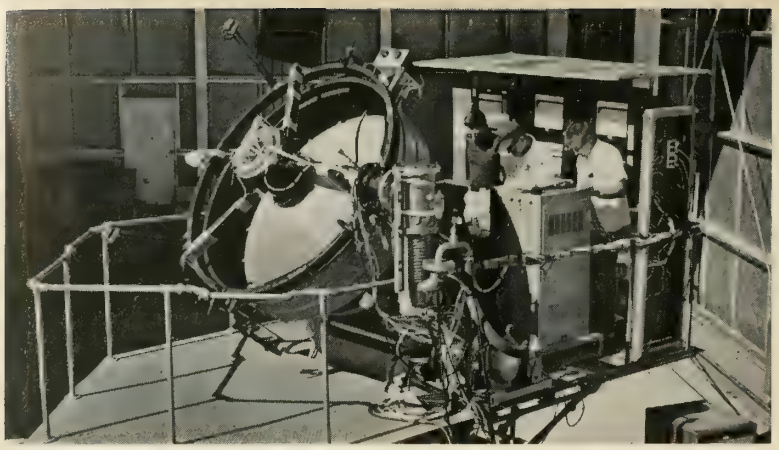
This is it.

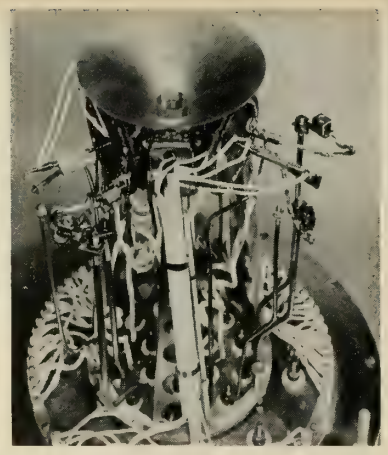


ghs only 8,100 pounds itself, unfueled.
here are a number of other reasons why the F-5 chosen for the Military Assistance Program.
ed. Outstanding climbing ability. Range.
ut perhaps one of the most important reasons is F-5's practicality. In operational squadrons, it will require considerably less man-hours of aircraft maintenance per flight hour than other supersonic fighters. And it will operate from the sod fields and unimproved runways of forward area bases—the first supersonic fighter designed to do this.

The F-5 will do many jobs. And do them well.

NORTHROP F-5





LEFT: *STEPS II test setup at GE's Solar Test Facility in Phoenix shows vacuum-encased generator positioned in front of 5-ft.-dia. solar collector. System logged 128 hrs. and 51 day/night thermocycles.* **RIGHT:** *Close-up of STEPS II generator-converter shows inlet cone and two of the three cesium-vapor converters. Peak power generated was 27.9 watts.*

solar space power

Thermionic Flight Experiment Studied

General Electric says system can be put in space within two years; space-station application seen

by Michael Getler

VALLEY FORGE, PA.—A study made here by General Electric Co. scientists indicates that an experimental solar thermionic power system, operating at about 5% efficiency with a 55-watt output, could be placed in orbit within two to two and one-half years.

The system, which GE estimates would weigh less than 200 lbs. and could be packaged in a cylindrical 43x40-in. shape, might ride as a piggyback payload aboard a *Thor-Agena*-type booster. During orbital injection, the system would separate from the main payload and operate as an independent vehicle.

To allow data collection specifically on thermionic system action in a first flight, a secondary electrical power system (probably solar cells and nickel-cadmium storage batteries) would be included to handle power needs for the major vehicle subsystems, such as tracking and command and telemetry.

This in-house GE feasibility study is actually a preliminary look by the firm at requirements for putting a workable state-of-the-art system into space as early as possible to assess its future roles in supply of space-borne power.

Dr. Joseph Danko, manager of advanced space power engineering for GE, expects that, when solar thermionic systems are raised to about 10% system efficiencies and are competitive in efficiency with widely used photovoltaic cells, they will offer about two times as much power with no increase in weight over the cells.

Additionally, Danko stresses that thermionic converters will be insensitive to the radiation effects that can degrade, and eventally cause failure in photovoltaics. However, he also points out that though converters may enjoy an advantage here, there is need for more study of radiation effects on the solar-energy collectors used in thermionic designs.

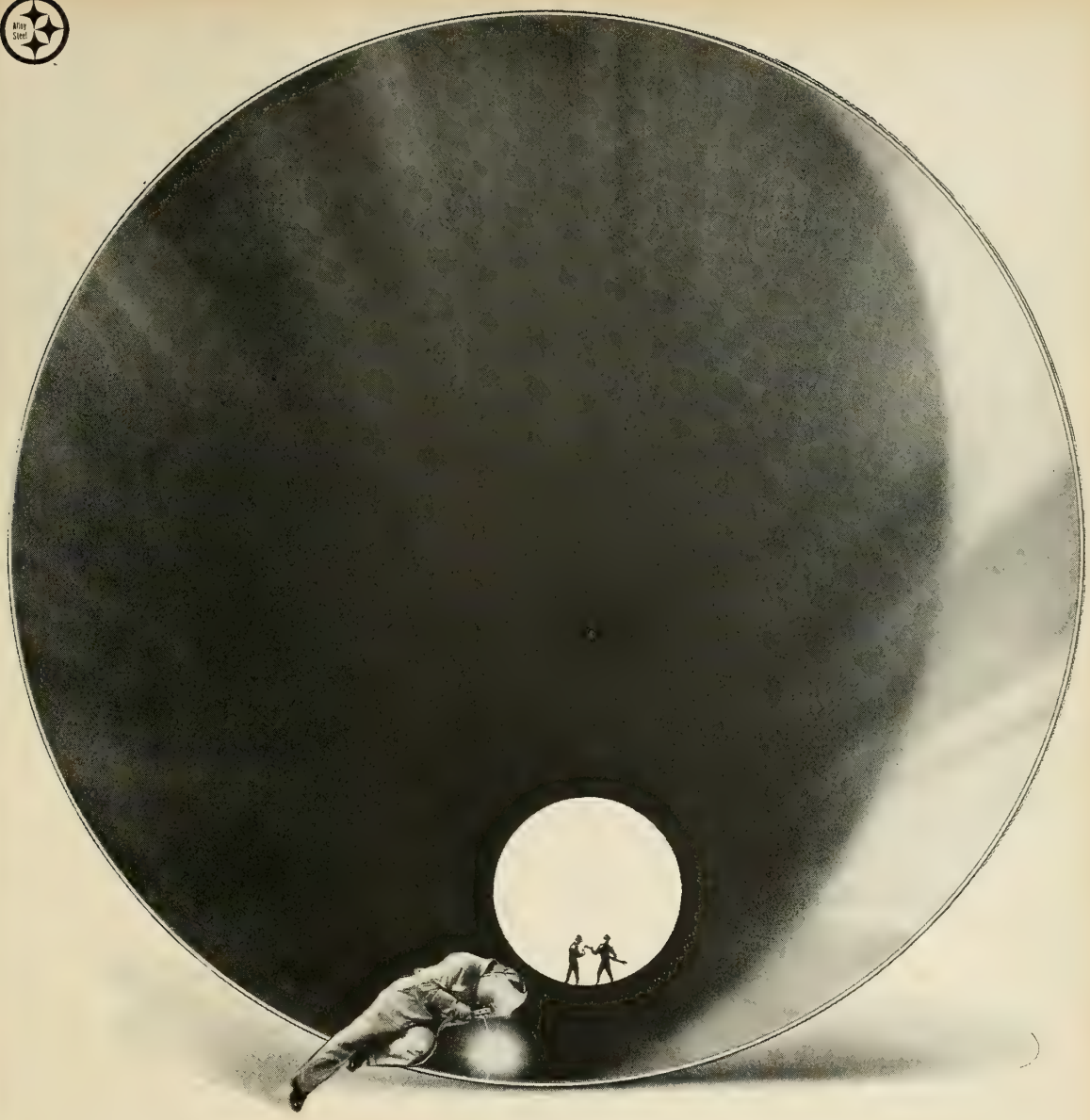
● **Manned station usage**—Danko feels that manned orbital space stations and advanced solar probes may be naturals for thermionic applications; that thermionics offer particular advantages in safety, weight, and repair over reactor systems in manned craft. "Thermionic supplies for a manned station could be developed within four to five years if a real push were made," he asserts.

The preliminary GE design calls for a cavity-type generator containing four or five cesium-vapor thermionic converters. The generator, designed to operate at cavity temperatures to 2000° K, is mounted with the inlet cone facing the focal point of a 3¼-ft.-dia. parabolic solar collector, The generator is held in this position by three generator support arms. Two of these 0.5-in.-thick beryllium rods are also used as electrical leads between the generator and load resistors—located in the vehicle equipment housing behind the collector.

The design of the thermionic generator is based to a large extent on work that GE has done under the AF-supported STEPS II (Solar Thermionic Electric Power System) program. However, Danko emphasizes that this program is not aimed at development of flight hardware and that considerable flight evaluation testing would have to be done before a firm design were chosen.

Danko told M/R that increased emphasis on flight hardware is vital in

(Continued on page 42)



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Solar Thermionic Power

(Continued from page 38)

order to be in a position to "get something up there as soon as possible so that future mission plans will at least be able to consider thermionics systems based on some actual data."

The generator will weigh about 5.5 lbs, will operate at 8% efficiency, and will have an estimated power output of 55 watts at 2.64 volts. This will require a thermal energy input of about 692 watts. GE estimates that converter efficiency will approach 10% with a cathode area of 2 cm^2 for each converter. Though the selection is not yet firm, the preliminary study lists rhenium as the cathode material and molybdenum as the anode material.

• **Tungsten wool**—To cut down on thermal loss and improve efficiency, GE plans to use layers of tantalum and molybdenum foil as radiation shields within the generator. There is also a possibility that a newly developed tungsten wool may be used in this context to "stuff the corners," GE reports.

The tungsten wool, the company says, has a very low thermal conductivity (0.004 watts per cm deg C) and is an order of magnitude better for this application than ceramics such as alumina and magnesia.

The converters also employ radiating fins for removal of waste heat and to improve the structural integrity of the package.

To orient the space vehicle's thermionic supply, a flywheel-gas-jet pointing system is included; this is reported to be accurate to 0.1 deg. These requirements, GE points out, fall between the *Nimbus* weather satellite and *Orbiting Astronomical Observatory* pointing demands (both control systems were developed by GE) and can be met with a simplified version of these systems using some already developed techniques and hardware. The solar paddles to handle system power demands on an experimental flight are also said to be an outgrowth of the GE effort on the *Advent* ComSat design.

While admitting that thermionics will require greater orientation accuracy than solar cells, GE reports, there are certain weight trade-offs inherent in thermionic systems, and the pointing requirements may differ widely depending on the mission.

In other tests recently completed at the firm's Solar Test Facility in Phoenix, GE began to collect data on the effects of misorientation of the solar collectors on power output. These first tests showed, Danko said, that a mis-

Circle No. 4 on Subscriber Service Card

orientation of 18 minutes of arc caused a 10% drop in power output, and a 30-min. inaccuracy caused about a 20% drop.

● **Phoenix tests**—These tests were part of another portion of GE's AF-sponsored STEPS II program. The Phoenix tests included continuous operation of an advanced thermionic system for what GE claims is "several times longer than it is believed any similar experiment has been able to perform."

According to Danko, the system logged 128 hours of testing in the sun and underwent 51 day/night thermocycles (simulating 300-n.-mi. orbit times). Danko said the equipment at the end of the test was "still in its original operating condition."

The STEPS II generator uses three cesium-vapor converters and can handle cavity temperatures approaching 2000°K (cavity temperature in the recent tests reached 1950°K). A 5-ft.-dia-parabolic solar collector reflects the energy into the generator, which is housed in a small vacuum chamber (with a small quartz window in front) to prevent oxidation within the generator. The entire ground experimental system is mounted on an antenna-drive radar pedestal with an automatic solar tracking system.

In the tests at Phoenix, Danko reports, the STEPS II system generated a peak power of 27.9 watts at 18 amps and 1.55 volts. It accumulated 2083 watt-hours for an average output of 16.8 watts. Generator efficiency, GE reports, was 2.9%, and overall system efficiency was 1.55%.

GE, with NASA support, is also working towards introduction of thermal energy storage concepts into flight hardware, which in future missions would qualify thermionics to handle the prime power requirements for space vehicles. Though these theories are not new, there is considerable interest within industry in the materials most suitable.

Basically, the concept involves use of a material with a high melting point compatible with thermionic operation that would be molten during periods when the system is exposed to sunlight but would solidify in darkness—releasing a sufficient latent heat of fusion to power the necessary systems.

GE, working with 3BeO-2MgO, reports it has measured yields of 264 watt-hours per lb. with the ceramic mixture. Danko says there are no plans to include thermal energy storage in the preliminary design they have come up with for a possible flight experiment. He claims this would set back a possible launch date at least 18 months. ■



Circle No. 5 on Subscriber Service Card

Tapco Now Top U.S. Nozzle Producer

Titan III-C 120-in. award goes to firm already fabricating nozzles for Minuteman, Polaris and Scout; vast research setup

by John F. Judge

A MULTIMILLION-DOLLAR contract to develop and fabricate huge nozzles for the *Titan III-C's* 120-in. first-stage solid motors boosts the Cleveland-based Tapco Division of Thompson Ramo Wooldridge Inc. into the position of number-one nozzle producer in the U.S.

Tapco already is producing *Minuteman, Polaris* and *Scout* nozzles in substantial quantities.

(The 120-in. contract does not make Tapco the sole supplier of nozzles for that motor. A similar contract was let by United Technology Center, developers of the 120-in. segmented boosters, to H. I. Thompson Fiber Glass Co.)

While no details are available on the fabrication of the 120-in. nozzles, it is known that Tapco has designed and built fixed nozzles of this type by starting with a steel outer shell containing plastic inner insulation and a low-erosion-rate liner, such as graphite. The inner sections are interlocked and bonded together.

The exit cones usually are constructed of a heat-resistant ablative material, sometimes reinforced with a structural wrap.

Tapco keeps its large booster nozzle facility separate from its tactical and strategic nozzle production lines, and there is a current in-house capability to handle nozzles for motors up to the 160-in. diameter class. This includes hydroclaves, wrapping, and machining units—all road-transportable.



PROTOTYPE Titan III-C nozzle, this Tapco-fabricated unit was used in first static test-firing of United Technology Center 120-in. segment. P. T. Angell, Tapco general manager (left) and James Rechin, large nozzle program manager, examine the component.

• **On the road**—In studies in progress on the next generation of nozzles—the 260 to 300-in. types—the road-transportability concept with respect to the fabricating equipment is being maintained. For the fabrication of this big equipment Tapco has semi-formal arrangements with several firms located on inland waterways.

Because the large nozzles pose the same transport problems as the big solids, Tapco intends to work out joint agreements with firms near water transportation, whereby the TRW division would move fabricating equipment into such a plant, and then would manage the technical aspects of nozzle manufacture and assembly.

With the 160-in. and smaller-diameter nozzles, Tapco has performed studies which indicate that these monolithic nozzles can feasibly be shipped by rail or road from Cleveland to any point in the U.S.

Tapco first started to move into nozzle manufacturing in 1956 by initiating heat-transfer and weight studies. Though the general area of exhaust control is an old one to Tapco, in this particular field, the prime contractors are better staffed and are constantly increasing their in-house nozzle design and development capabilities.

While the subcontractor's engineering and development activities seem to be diminishing, there still is a need for such a capability to carry design through to manufacture, and to help define hazy interface areas between manufacturing techniques and quality problems. Tapco maintains a high quality engineering staff for this purpose.

There is considerable support activity behind Tapco's production-line nozzles—ranging from a vigorous materials research effort down through the development of manufacturing techniques suitable for the highly specialized components.

In the management structure of

TRW, Tapco is one of six operating divisions consolidated into what is termed the Electro-Mechanical Group under Vice President Stanley C. Pace. This group, in turn, is one of five similar entities forming the corporate structure of TRW. Space Technology Laboratories is one of the five groups.

● **New look**—Although missile and space work had complemented the aircraft components business for several years, a reorganization in 1958 enabled Tapco to concentrate more fully on missile and space activities and projects. Since this shift, the division has increased its percentage of engineering talent until better than half of Tapco's 2000 employees are engineers, scientists and technical support personnel.

Under Vice President and General Manager Pierce Angell, the division is taking on a new look. The once confusingly long list of development areas has narrowed to reflect an increasing concentration on missile/space activities. Major development areas now include auxiliary power systems, rocket nozzles, fuel pumps, reaction controls, thrust-vector controls, advanced energy-conversion systems, underwater-propulsion systems, electrical controls and turbine-driven energy systems.

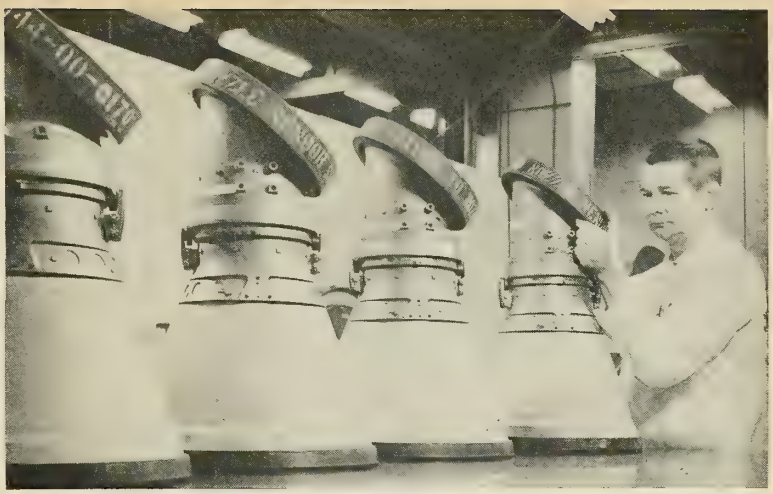
As a result, the division sometimes finds itself competing with its own customers, but Angell points out that this has always been the case, especially in the highly profitable automotive areas within the corporation. There is plenty of experience in this type of business at TRW.

In terms of corporate planning, Tapco is divided into six specific product areas—or profit centers—and two research operations. These include: rocket engine components, reaction control systems, power systems, fluid systems, Rankine cycle systems and electrical products; and new product research primarily in electro-mechanics and materials research. The Research, Development and Engineering Dept. is headed by Dr. William A. Johnson.

● **Biggest push**—While the discrete separations aid in planning, there is a great deal of coordination among the activities. Tapco's materials research effort is probably the largest of any industrial contractor in the nation in this wide field.

The Materials Technology Research and Development Center, under Dr. Arthur H. Grobe, supports the several divisions of the Electro-Mechanical Group, but still is a functional part of Tapco Research, Development and Engineering.

Housed in the Colwell Engineering Center, the Materials Research Group conducts chemical and metallurgical research on a wide range of materials and investigates processing techniques for hard-to-fabricate metals and alloys.



BRACE OF Minuteman third-stage nozzle assemblies are readied for shipment to Hercules Powder Co., stage contractor. Tapco keeps weapon system nozzle work separate from the large booster nozzle fabrication lines.

In the chemical areas, researchers are delving into the high-temperature compatibility problems associated with refractory metals. Studies include investigating the reactions between these metals and combustion products at ultra-high temperatures.

Coatings are being applied to the columbium and tungsten alloys, and liquid metal studies covering corrosion problems in containment also are underway.

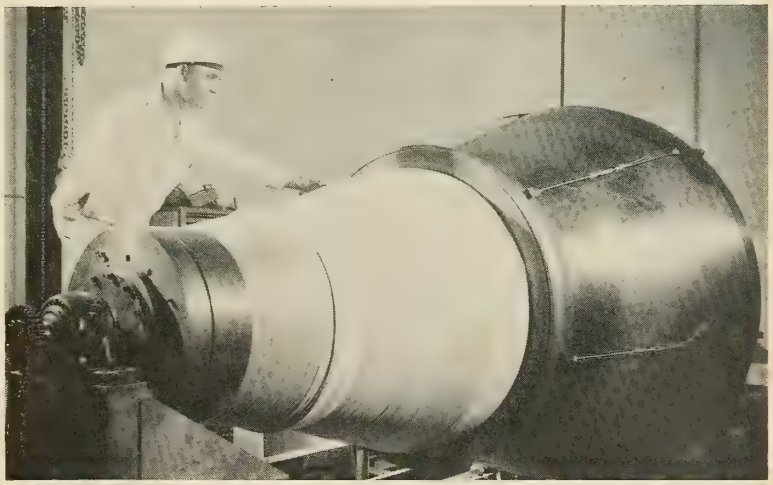
Physical and mechanical metallurgy investigations deal with the behavior of metals at temperatures above 4000°F; fracture and crack propagation; and factors influencing maximum strength achievement.

The research organization maintains a complete array of metal fabrication equipment, including an extruder, a Dynapak, furnaces, and electron-beam welders, as well as brazing, rolling, diffusion-coating and vacuum heat-treating facilities.

In addition, studies of reinforced plastics materials application and materials engineering are in progress.

Applications problems and their solution are tied closely to the major planning programs. For example, the research center is working on thrust-vector control problems from a materials standpoint—covering such topics as erosion problems for tungsten flapper valves in hot-gas systems; cooling concepts involving controlled porosity and infiltration techniques; and materials problems in reaction motor nozzles in an oxidizing environment.

It is because of this highly varied but precisely directed research effort that Tapco has experienced some suc-



LARGE EXIT cone liner during the wrapping operation at Tapco. The firm's plastic department works closely with design engineers and manufacturing personnel in the production of the large nozzles.

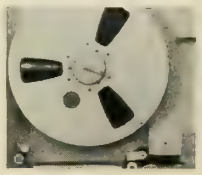


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cess in developing laboratory tungsten piping for thrust-vector control. This is aimed at 120-inch and even larger solid boosters, though the program still is in its infancy, and it is representative of the types of applied research solutions achieved almost as a matter of course by the division.

Tapco is deeply involved in work on various types of thrust-vector-control-swivelling nozzles and static nozzles with fluid injection. Though the art of TVC seems to be completely separate from nozzle considerations, the process of mating a control system to exhaust apparatus makes it an integral design problem. Tapco is not producing such apparatus under the recent 120-in. nozzle contract.

Tapco researchers and planners are convinced that the hot-gas bleed approach is the best one for future propulsion system thrust-vector control. The hot-gas work is being carried out at temperatures about equal to those reached in the current state of the art in propellants. There is high confidence at Tapco that the approach can be applied to the next rocket development.

Hot-gas bleed systems have been demonstrated, and the division is under contract for both modulating and on/off systems. In addition to the success experienced here, Tapco experts claim that direct-bleed TVC is the only answer for large boosters, because of weight, volume and other physical characteristics—but the prime impetus for the concept is reliability. Liquid TVC work has all but halted at Tapco.

Another primary product area is in the field of small, pulse-modulated rocket engines for reaction control. Tapco expects this area to grow, and is funding work at Cleveland, Inglewood, Calif., and Roanoke, Va. These engines are not primary propulsion units but are aimed at attitude-control and stabilization applications.

Both ablative and radiation-cooled units are under investigation, as are a wide variety of propellants. The division has passed the 150,000-firing mark in development efforts covering all thrust-level ranges. This includes work under a subcontract from Douglas Aircraft for development of attitude-control rockets for the *S-IVB* stage of the *Saturn V* booster.

The materials technology for ablative rockets is available from the rocket engine component area; but these designs are usually short-duration types. The problem here is to extend the capabilities of materials in operating time —15, 30 and 60 min. Research also is aimed at reducing the pulse duration and increasing the response capability.

Tankage and fuel-expulsion methods are under study with respect to the high-energy, highly corrosive propellant combinations. ■



Boeing has primary developmental, building and test responsibility for NASA's Saturn S-1C advanced first stage booster. Aero-Space Division's Saturn Booster Branch has immediate, long-range openings offering professional challenge and rapid advancement to graduate engineers and scientists.

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New Method for Recovering Helium

Linde process bids to make economical extraction of rare element from natural gas with low content

A NEW helium extraction process in the works at Linde Co., division of Union Carbide Corp., may open the way to economical recovery of the rare element from natural gas lines.

Based on a selective permeability principle, the Linde method can produce helium at a cost at least 50% lower than that of any current diffusion process, developers say.

The myriad aerospace and nuclear demands for the inert gas account for more than 80% of the total volume produced in the U.S.—and the figure is still growing. Much of this total is produced through low-temperature techniques, but an estimated 10 million cu. ft. of helium is released to the atmosphere every day through use of natural gas.

The Linde method may alleviate this problem—a crucial one, since nature placed the Earth's most abundant supply of helium in a few natural gas fields scattered around the interlocking borders of Texas, New Mexico, Oklahoma, Arizona, Colorado, Kansas and Utah.

A vast program involving construction of five new helium plants will start stripping helium from natural gas in this area before it enters commercial channels. This gas is relatively rich in helium, having 1-8% concentration.

The new plants will be built and operated by four private firms—Helex Co., Phillips Petroleum Co. of Bartlesville, Okla., Cities Service Co. of N.Y., and National Helium Corp. All are under contract to the Interior Dept. in a long-range helium conservation program.

The individual contracts were scrutinized by the General Accounting Office and the result was a series of price redetermination agreements between the firms and the Interior Dept.

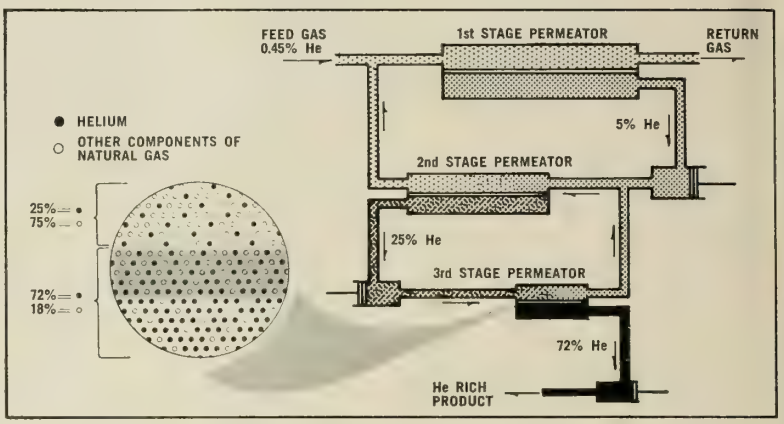
The process involved in each case separates the helium from the natural gas through cryogenic means. This is economical because of the relatively high helium concentrations.

• **Selective membrane**—The Linde method may allow helium recovery from natural gas sources with only a fractional helium content. The key to the method is in the development of a fluorocarbon membrane—Teflon FEP—which combines high helium selectivity with high through-put rates.

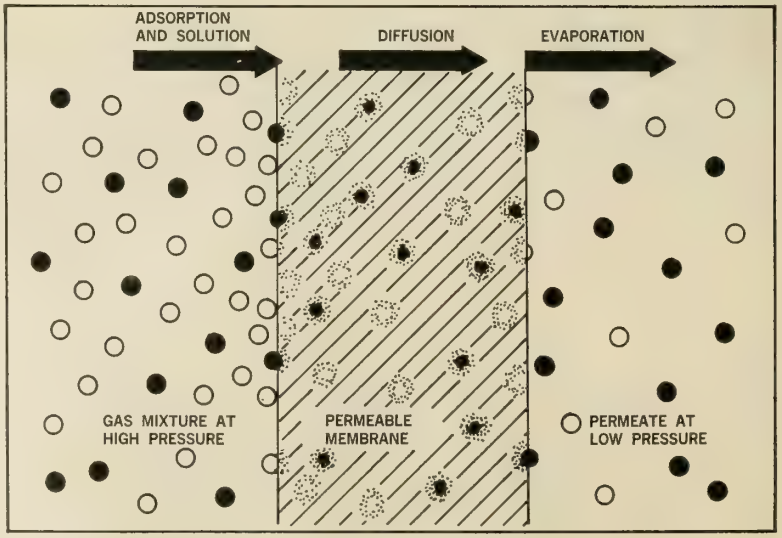
The permeation of helium through a non-porous membrane, such as the copolymer of tetrafluoroethylene and hexafluoropropylene, is a complex phenomenon, say Linde experts. It involves adsorption of helium at one interface; solution into and diffusion through the organic membrane; and evaporation at the opposite interface.

In addition to its high helium selectivity, Teflon FEP also exhibits a high absolute permeability to the gas. It is chemically inert, with excellent stability and mechanical strength over a wide range of temperatures. Finally, Teflon FEP can be heat-sealed to itself and to various metals.

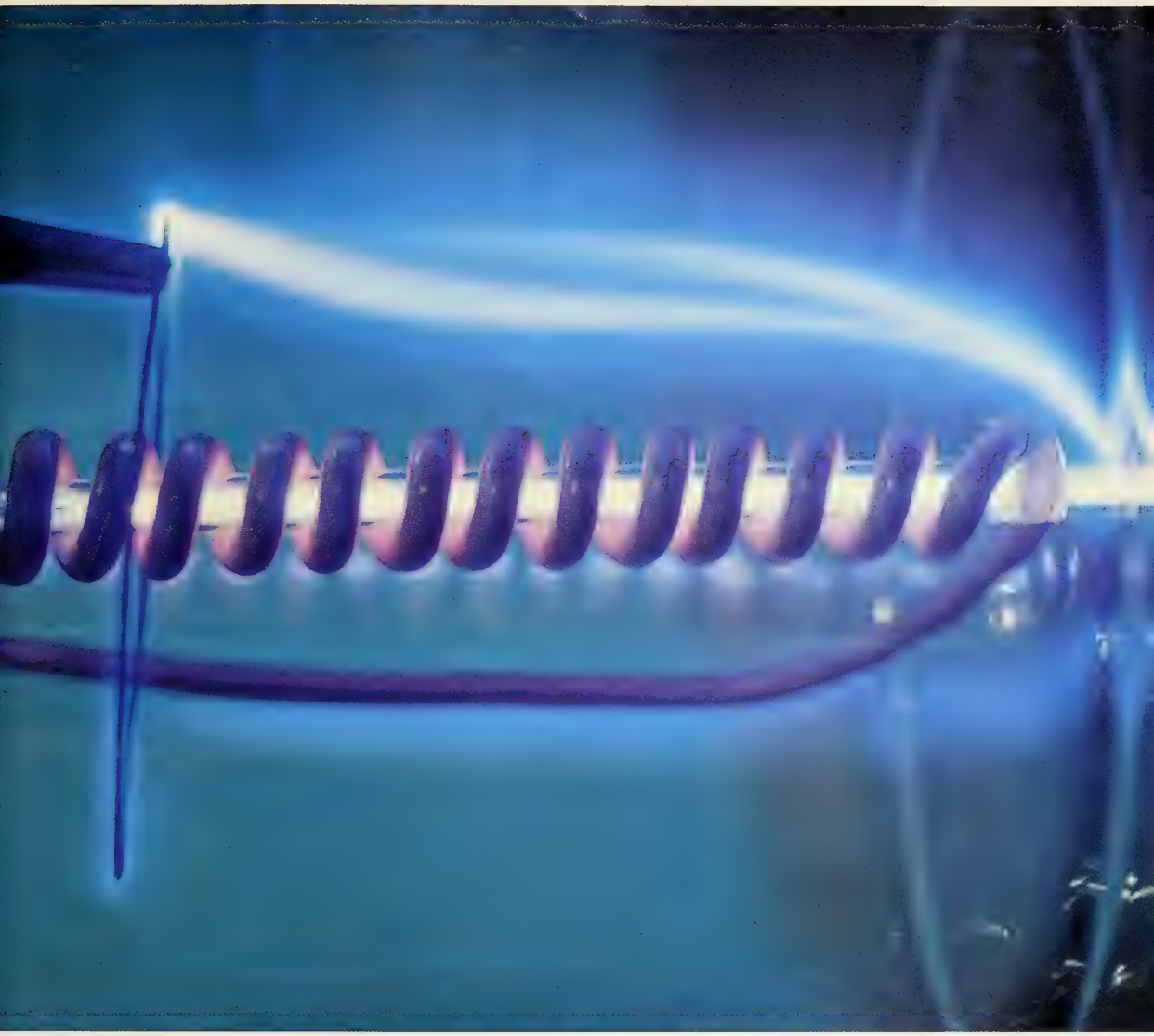
Linde scientists have perfected a practical and inexpensive method of supporting large surface areas of these organic membranes under high pres-



THREE-STAGE permeation system for helium recovery from natural gas.



PROCESS involves adsorption of helium at one interface of membrane, solution into and diffusion through organic membrane, evaporation at opposite interface.



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NEW, 24-page manual, *Engineering with Silastic*, is now available. Contains design data. Write Dept. 6216, Engineering Products Division, Dow Corning Corporation, Midland, Michigan.

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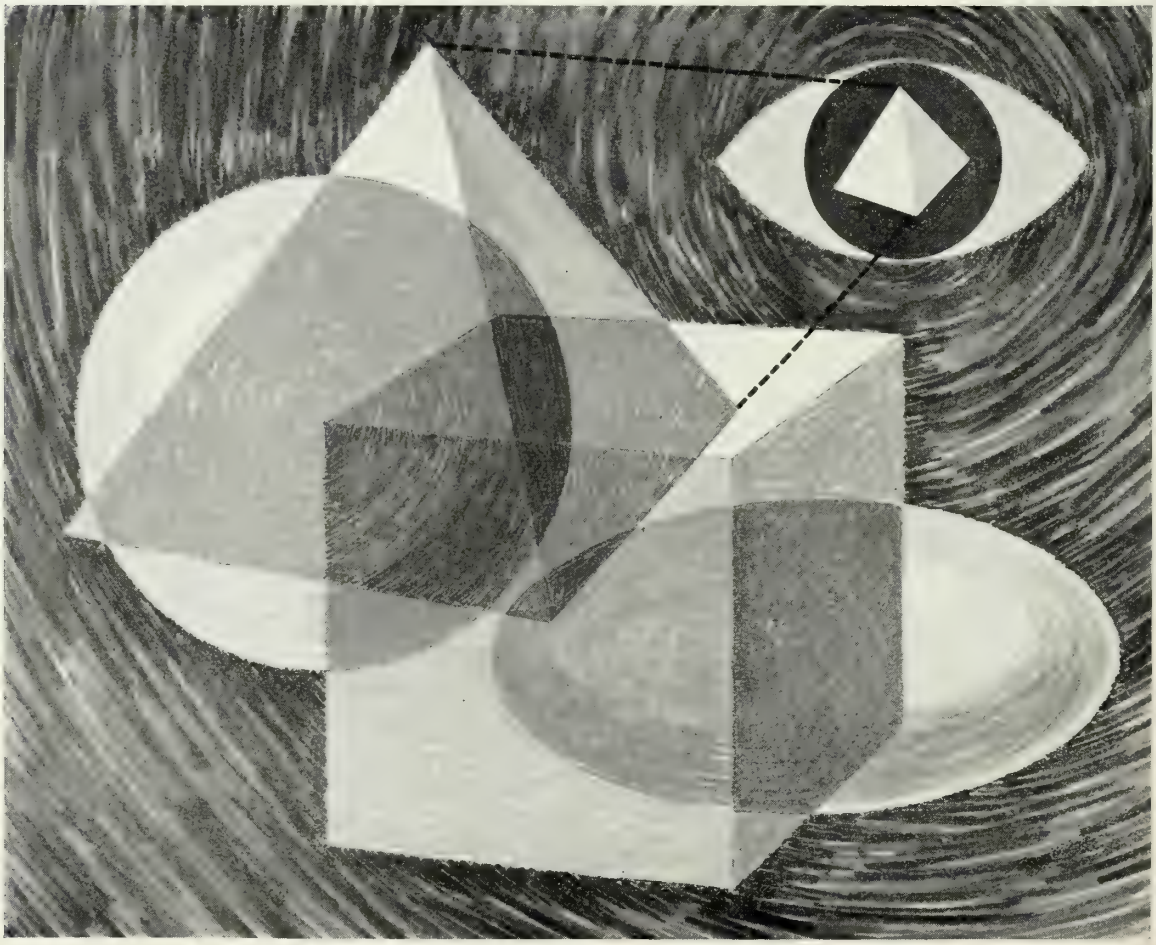
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THE NEW GENERATION OF JUDGMENT MACHINES

...AND WHAT DOUGLAS IS DOING ABOUT THEM

There is a critical need in defense and space work for automatic equipment that can go where a man cannot and perform decision functions that up to now only a man could handle. □ To meet this requirement, a new type of computer has been developed in the laboratories of Astropower, a Douglas subsidiary. Called an "Optical Decision Filter", it can recognize and classify three dimensional objects regardless of their size and orientation with respect to the viewing lens. □ The capabilities demonstrated by this Astropower unit give it great potential for application in many defense, space and electronic fields, including the following: photographic analysis; radar signature analysis; ballistic missile decoy discrimination; and starfield (or other pattern) recognition.



This step ahead in the computer field is among the numerous research programs in 23 broad technological areas now under way at Douglas. Major Douglas Divisions are located in Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

DOUGLAS

sure differentials. The recovery process has been tested over a period of six months, using helium-bearing natural gas from Kansas pipelines. The results showed that neither the selectivity nor the permeability of Teflon FEP was affected by natural gas, even after extended time.

● **Process operation**—The Linde method consists essentially of feeding a stream of helium-bearing natural gas at pipeline pressure and at a moderate temperature (150° to 200°F) into the high-pressure side of special permeation assemblies. A small fraction (about 5%) of the crude stream is allowed to permeate through the membranes.

This fraction is helium-enriched by a factor of 10 or more and removed at a pressure below atmospheric. The remainder of the gas is returned to the pipeline. Higher helium concentrations then can be obtained by using two or more permeation stages.

Several types of permeation systems have been studied by Linde engineers. Initial findings show that a three-stage system for recovering about 60% of the helium in natural gas is the most practical.

Many variables for FEP permeation were investigated in an effort to attain the highest rate consistent with the maximum concentration of helium recovered. Linde engineers found that, by permeating only 5.3% of the feed gas, they could recover 60% of the total helium content, producing a helium concentration in the permeate of 5%.

For example, if 100 ft.^{3} of gas containing 0.45% ft.^{3} of helium were fed over the permeation equipment, 5.3 ft.^{3} of permeate would contain 0.26 ft.^{3} of helium and result in a 5% helium concentration in the product.

A second permeation stage would increase the helium concentration to 25% and a third would up this to 72%. (All concentrations are in mole-percent). The operating temperature here would be 176°F—low enough to avoid decomposing the components of natural gas.

The separation process could be performed at much higher temperatures, if necessary, in view of the high thermal stability of Teflon FEP.

Linde experts claim the permeation process is superior to the current quartz-tube diffusion method in every way except selectivity. With any given natural gas stream, Linde spokesmen say, their recovery process can extract a 70% helium product—as required by the Government's conservation program—for less than half the investment needed in the quartz or diffusion-through-glass process.

Very little additional investment is required to provide for upgrading helium product from 70% to 100% purity. The bulk of this investment lies in the

ENGINEERING EMPLOYMENT OPPORTUNITIES

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equipment needed to make the primary separation of helium from natural gas.

While Linde spokesmen say their process is the most efficient now available, preliminary economic evaluations indicate that large-scale extraction procedures will not be competitive with the more advanced cryogenic processes.

Dr. S. A. Stern, chief of the Linde development team, says "This is true today, but with so many variable factors to consider, the story could be markedly altered tomorrow." ■

Helium's Space Age Uses

TOUGH, LIGHT metals used in today's aerospace industries must be welded in an atmosphere of helium or other "inert" gas.

Impurities in the air or oxygen cause materials like magnesium, aluminum, stainless steel and titanium to explode or turn brittle when welded. Magnesium and titanium must be purified or degassed in their production by a stream of helium.

Another major demand for helium grew from discovery of controlled atomic fission. Helium conducts both heat and electricity well. Ionizing radiation affects its structure very slowly, and helium becomes radioactive very slowly. Helium has only two isotopes; helium-6 has a half-life of eight-tenths of a second, and helium-3 occurs only one time in 100,000.

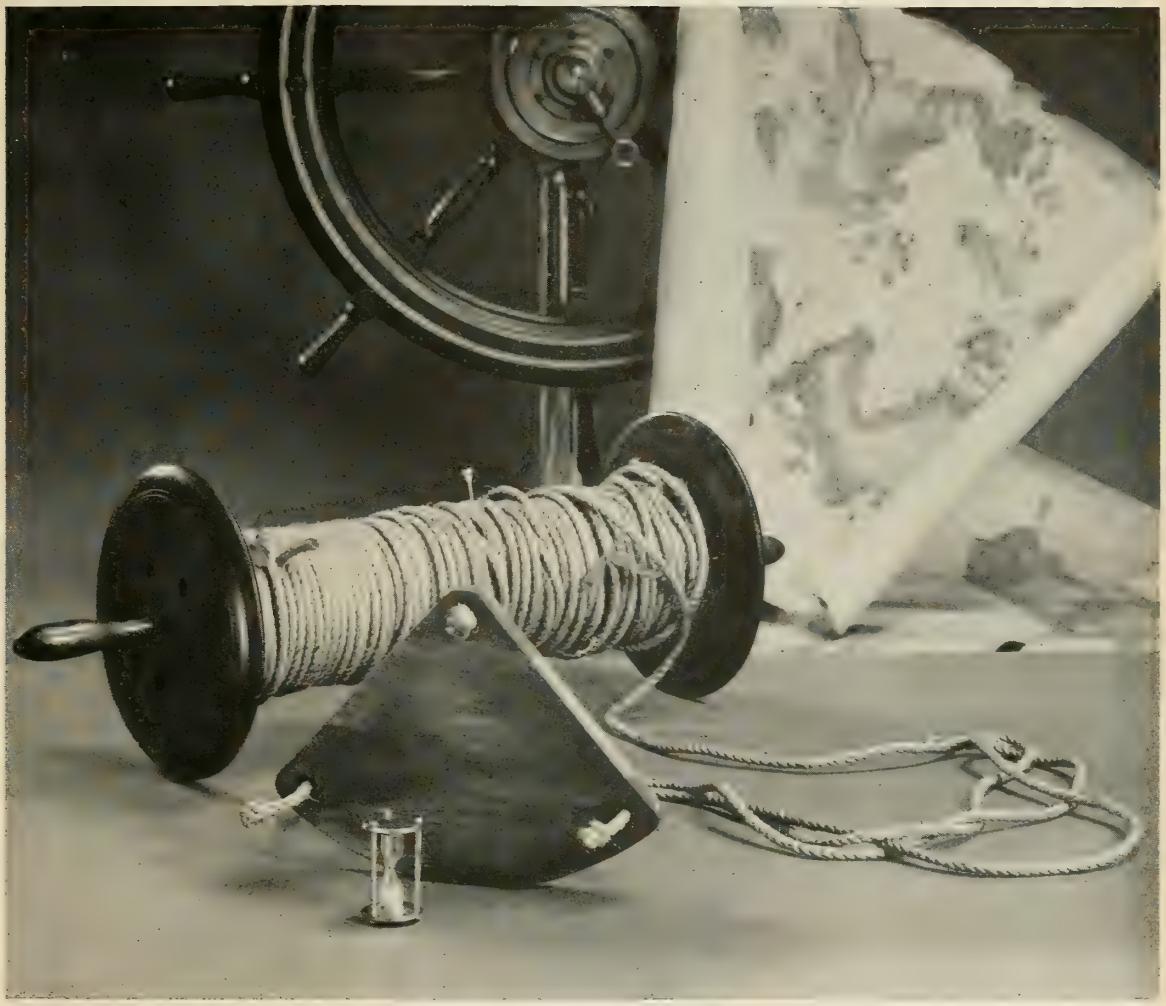
Radiation resistance and good heat conduction gave helium the job of cooling many atomic reactions, including the reactors and production equipment. It also proved a good test gas in the miles of pipes and acres of shielding that contain the radioactive products of fission.

New uses require helium of unprecedented purity, and World War II plants have been modified to upgrade the gas from 80% to 99.995%. All helium produced today contains only 50 parts per million of other gases, mainly neon, nitrogen, and hydrogen.

Helium prices fell to their lowest in the artificial wartime economy. The price was $5.36 per 1000 cubic feet. By 1949, with some of the plants closed, the price rose to $12.95. Nearly 80% of all the helium known to have been produced in the world was extracted after 1949.

All the plants reopened before 1954 and were producing at peak capacity as heliarc welding, atomic industries, and the missile-space industry entered an era of phenomenal expansion.

FROM CHIP LOG TO ACCELEROMETER



Chip Log (19th Century)—The earliest device known to measure a ship's speed. The chip was attached to a line knotted at specific intervals and drawn through the water during a measured 30 seconds. The knots were then counted, indicating the nautical miles per hour the ship was making. (Dossin Museum)

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Dr. Herb (E. H.) Phelps got his BChE from Clarkson College of Technology, and his MS and PhD from Case Institute of Technology. He joined USS in 1955 after three years in corrosion work at Wright Air Development Center. He is a member of the National Association of Corrosion Engineers and the Electrochemical Society.

Atmospheric stress-corrosion tests of bent-beam alloy and stainless steel specimens offer a guide to specification of steels for aircraft and missile uses. The microstructural characteristics of stress corrosion are investigated in several USS research projects.

"In the design of ground support equipment, critical days or months can be lost solving problems which may already have been solved for you . . . that's why you should come to U.S. Steel with your corrosion problems"

—Herb Phelps, Division Chief, Corrosion Technology Division, Applied Research Laboratory, U. S. Steel Corporation

"Corrosion losses in the United States amount to about $7 billion every year, and here in our Applied Research Laboratory at Monroeville, Pa., we're doing something about it," says Herb Phelps. "In fact, we're doing substantially more than anyone else in the industry.

"The story of our corrosion program goes back to March 1, 1929. That was before my time, but the steel that resulted from the first program—USS COR-TEN High-Strength Low-Alloy Steel—is still more in demand than any other high-strength, corrosion-resistant steel on the market. When COR-TEN Steel was introduced, our tests enabled us to show that it had 4 to 6 times more resistance to atmospheric corrosion than carbon steel had. This ratio has been fully substantiated by later testing programs that have also developed atmospheric corrosion data for hundreds of other experimental compositions.

"Since 1929 we've exposed over 64,000 samples of steel in corrosion tests, some of them for as long as 30 years.

"Today, we literally have acres of test racks around the country, exposing samples of every steel used in metalworking to rural, industrial, and coastal atmospheres. We have hundreds of samples built into structures, inserted in pipelines and vessels used by dozens of processing industries, and during the winter months we even expose samples underneath the front bumpers of about 70 automobiles to determine the effects of road salts.

"But that's only part of the story. Here at the Applied Research Laboratory, we have a full-time crew of 28 technicians who complete over 100 test programs every year on applications for steel products. We're trying to find out the cause of stress corrosion, for example, and how proper design and special treatments can prevent it. We investigate things as mundane as the corrosion of stainless steels by dairy cleaning compounds, and as exotic as corrosion-erosion of sensitized stainless in a thorium dioxide-uranium trioxide slurry, which is the rather high-sounding name for a certain type of fuel and coolant for a nuclear-reactor power plant.

"I think you'll agree that if you have a corrosion problem, we're the people to see. We often investigate customer corrosion problems in the field. If you have a corrosion problem and want our help, call the USS Office nearest you—or write to United States Steel, Room 6720, 525 Wm. Penn Place, Pittsburgh 30, Pa." USS and COR-TEN are registered trademarks.

USS United States Steel



Corrosion-test installation at Harbor Island, North Carolina. The importance of sea-water testing is emphasized by U. S. Navy statistics that point out that every $1 spent to prevent corrosion on ships ultimately saves $90.



Research into the mechanisms of corrosion is an important part of United States Steel's corrosion program. This device, a potentiostat, measures the current required to maintain a constant potential in the electrochemical processes of corrosion.

IRBM Work Aids French Space Hopes

Nation to spend billions on nuclear space programs; rocket R&D progresses toward '65 satellite shot

by Bernard Poirier

PRESIDENT Charles de Gaulle's intense interest in the development of France's independent nuclear strike force is based in part on the boost it will give to the nation's ambitions in space.

France has embarked on a national space effort of major proportions. She also is a full partner in a $300-million European space program which has its headquarters in the same Paris office building that houses the French Space Agency.

Enjoying an unprecedented prosperity, the French have committed themselves to spending billions of dollars on nuclear-tipped missiles, big space rockets and satellites. At the same time, to get maximum mileage out of each franc, they have scrapped some antiquated agencies and bureaus. Others, like the Intermediate Range Ballistic Missile Agency (SEREB) and the National Space Agency (CNES), have been streamlined.

Since a fine line separates a military IRBM rocket stage from a stage used in a satellite launching, research activities for both are merged at the laboratory level. Thus, when new rockets such as *Agate* and *Eridan* are sent up, both space and military representatives are on hand.

● **Progression**—A new rocket more than 50 ft. high, called *Emerald,* is expected to be launched this year, it is reported from Paris. Its first stage will use liquid fuel, and the two upper stages will be inert.

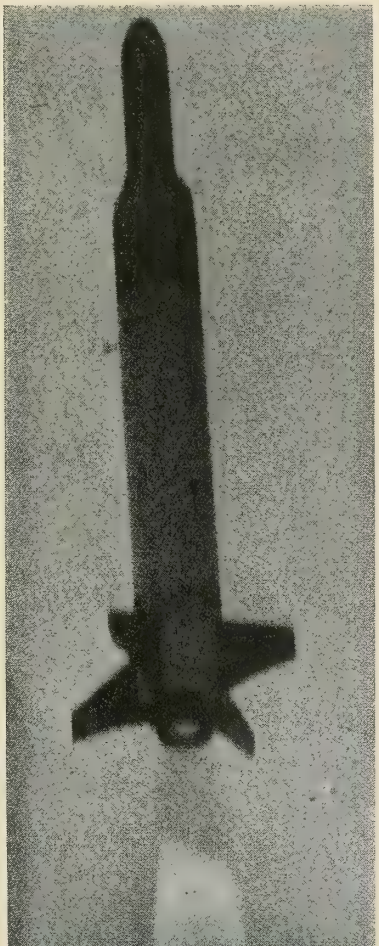
Emerald will be followed by test flights of the *Sapphire* rocket, which will use the *Emerald* first stage and a new solid-fuel second stage. By all early descriptions, this second stage will resemble the first stage of an IRBM.

The last stage, also solid-fueled, will complete the last of the "precious jewel" series, the *Diamond* rocket. France pins on *Diamond* its hopes to put up its first satellite in early 1965.

(M/R's own sources in Europe reported after this article was written that France has successfully launched a guided solid-fuel IRBM test missile called *Topaze,* which is configured with "four moving nozzles."

(*Topaze,* a 23-ft. single-stage vehicle, is expected to be the basic design of the second stage of *Sapphire* and *Diamond.*)

Gen. Aubinière, executive director of the Space Agency, says the first satellite in the French program will weigh 176 lbs. Its planned orbit would take the satellite over portions of Texas, Louisiana and Florida.



FIRST RELEASED photo of France's 30-ft.-long Agate rocket—forerunner of a nuclear IRBM.

Last July 17, France announced that a new rocket-launching site will be built at Mont-de-Marsan, on the southwest coast about 70 miles south of Bordeaux. Such action had been expected, because the main French rocket test site at Colomb-Béchar eventually will be evacuated as part of the Algerian settlement.

● **Westward, ho?**—An unusual feature of this new site is that France might launch her satellites westward toward the United States and Mexico, rather than risk overland flights along the Mediterranean, and the chance that empty first- and second-stage motors might fall on her neighbors.

No nation has yet launched satellites to the west, because it is easier to launch with the eastward motion of the Earth. Hence, the French might find themselves in the tricky position of driving against the traffic.

One new international agency settled in Paris by seven nations is ELDO—the European Launcher Development Organization. ELDO will build the rockets used to orbit satellites constructed by another new international agency—ESRO (European Space Research Organization)—also located in Paris.

Most West European nations are either members or observers in both organizations. The leaders are Britain, France and West Germany. These three will build the large rockets necessary. Others, such as Italy, can be expected to be active once final plans are adopted.

The only non-European participant is Australia, which gets into all ELDO and ESRO discussions because its vast Woomera Rocket Range has been selected by the Europeans for their multilateral launchings.

Launchings from Woomera will be to the east, but these satellites will be the first to be launched from the Southern Hemisphere.

For most Americans, the first inkling of French interest in space matters came with the transmission of TV programs from France to the U.S. via the *Telstar* satellite. ■

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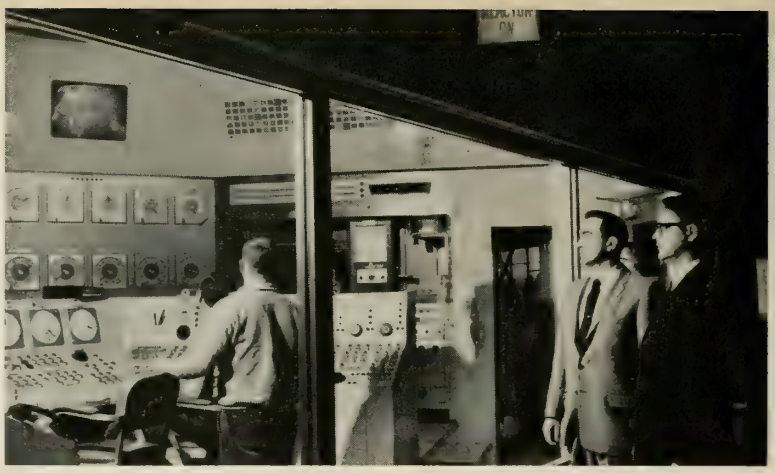
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PLUM BROOK officials watch reactor as operators bring it up to full power.

nuclear space power

Plum Brook Reactor Tests To Start in June

NUCLEAR ROCKET experiments begin in June at NASA's Plum Brook Research Reactor in Sandusky, Ohio.

The scheduling of the first experiment—which will test the behavior of various metals in a reactor environment—was revealed as the space agency announced that the Plum Brook facility reached its rated 60,000-kw power for the first time on April 21. Officials said the full-power run will permit experiments to begin in June, if no problems develop.

The first test, conducted jointly by NASA and the Lockheed Aircraft Corp., is designed to provide information on the behavior of metals in the reactor environment. Such metals face a two-fold problem: exposure to cryogenic temperatures; and radiation from the reactor.

The test program—which will last two years—will expose to the reactor's radiation small samples of metals in a helium atmosphere at temperatures below —400°. The work will begin with samples of alloys of aluminum, titanium and stainless steel, which will be stretched and deformed in the helium while still in a radiation zone.

In addition to experiments in basic nuclear physics, the Plum Brook Reactor also is slated for studies on the Nerva engine actuator. The actuator cycle will be tested in the reactor to simulate the operating conditions it will face in space—tremendous heat on the side next to the reactor power source; severe cold in the mechanism nearer the outside of the vehicle; and damaging radiation throughout.

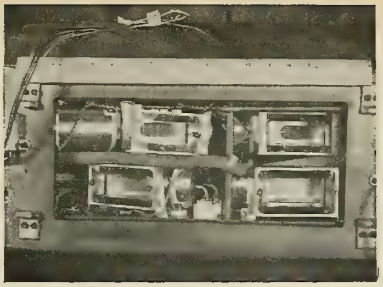
● **Up by stages**—The power buildup to get the reactor ready for the experiments was a long process. Both nonnuclear and low-reactor-power testing were completed in 1962. Last January, NASA received authorization from the Atomic Energy Commission to operate at full power.

The first "approach to power" began Feb. 16, as Plum Brook engineers guided the reactor up the power scale in an intentionally slow operation that lasted almost a month. When the reactor reached 200 kw, the engineers stopped the gradual increase, holding the reactor at this power for a full day, to check and calibrate the instruments. The next 24-hour hold was at 400 kw—less than 1% of the reactor's full power. Carefully, the reactor was checked out at the 2000-, 4000-, 6000- and 15,000-kw levels. Then bigger steps were taken—25,000 to 35,000 to 40,000 kw. At each level, the reactor, its instrumentation and its biological shielding were evaluated and cleared before the power buildup continued.

On April 19—after replacement of the fuel elements—the final power test was begun. The 200-35,000-kw range was passed through quite rapidly. The power buildup slowed down as the research reactor reached 75% of power, and full 60,000-kw power was reached on April 21. ■

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Currently, measurements of variations on the earth's magnetic field are being made at remote islands in the Pacific Ocean, providing clues to the effect of solar activity on its shape and stability. The influence of solar wind on the geomagnetic field is also being investigated in laboratory experiments, by bombarding magnetic fields with clouds of highly ionized gases.

Scientists at Lockheed are engaged in a continuing program of designing and placing density gages, mass spectrometers, ion traps, and similar instruments on space vehicles to measure the density, composition, and temperature of matter in space. These experiments lead to a better understanding of the chemical reactions occurring in the atmosphere high above the earth.

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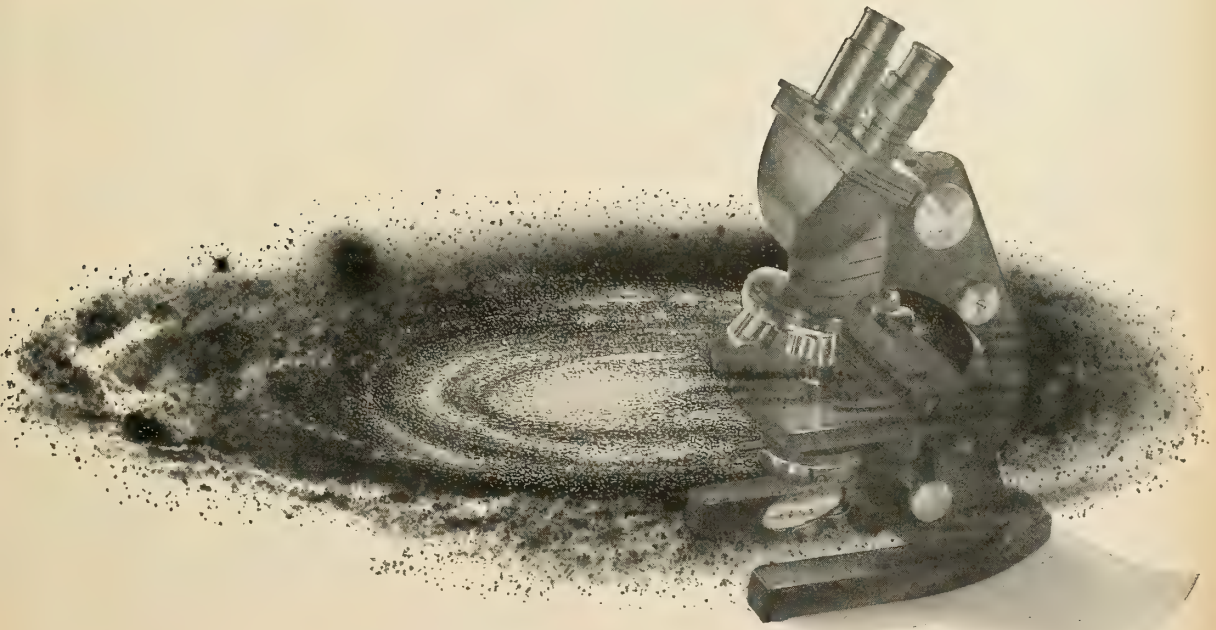
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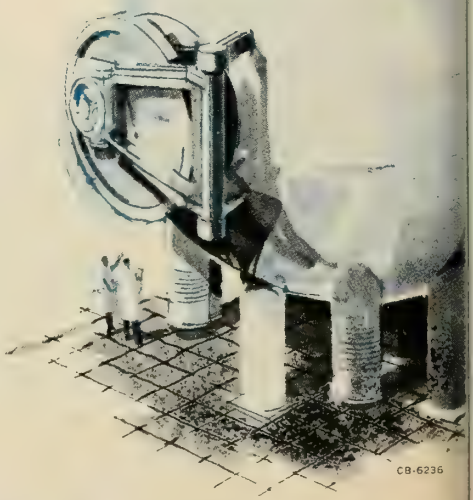
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New Firms and Divisions

California Computer Products, Inc., Anaheim, Calif., designers and manufacturers of automatic plotting equipment for digital computers, has established a subsidiary, Nederlandse Computer Maatschappij N.V., with headquarters in Amsterdam, The Netherlands. The new company will distribute CalComp equipment in Free Europe. . . . *Space Technology Laboratories has organized a new operational systems office at San Bernardino, Calif., to manage operational engineering functions for ballistic missile activities. The new office will serve as a focal point for the correlation and integration of all operational engineering programs for the Air Force Logistics Command and Strategic Air Command.* . . . Voltronics Corp. has been established at 296 Route 10, Hanover, N.J. The company will manufacture electronics components, including a broad line of precision trimmer capacitors. The firm has purchased the assets of Voltronics, Inc., of Westbury, N.Y. . . . *The National Electrical Manufacturers Assoc. has formed a new thermoplastic conduit, duct, and accessories section in Chicago. Sixteen companies have affiliated with the section, a subdivision of the Building Equipment Div. of NEMA.*

Industry Facilities

Hewlett-Packard Co. has announced plans to build a new plant in Colorado Springs, Colo., for the design and manufacture of oscilloscopes. Construction of the new plant is scheduled to begin about June 15. . . . *The Naval Missile Center at Point Mugu, Calif., has begun construction of a new 48,000-sq.-ft. simulation and vectoring facility. The facility is to be used for simulation of all parts of weapon systems and for directing missile-carrying aircraft into correct position for launching missiles against airborne targets.* . . . Litton Industries' U.S. Engineering Co. division has selected Springfield, Mo., as the site of a new 28,000-sq.-ft. plant to be completed by December. The building will afford space for manufacturing multi-layer circuits and weldable interconnections for aerospace and nuclear industry, plus a research and development laboratory and administrative offices for USE's vice president and general manager. . . . *Radiation Inc., Melbourne, Fla., has added a new analog computer to its computer facility in Melbourne. The new Electronics Associates 231R analog computer supplements the firm's existing IBM 1620 digital computer.* . . . Aerojet-General Corp.'s corporate offices have been moved from Azusa to El Monte, Calif. New address is 9190 E. Flair Drive. . . . *Canoga Electronic Corp., Van Nuys, Calif., has signed a lease for a new 50,000-sq.-ft. manufacturing and engineering facility in Chatsworth, Calif. Among the products to come from the new facility are radar, telemetry and digital data handling systems, antennas, pedestals, and related subsystems.* . . . Datatrol Corp., electronic data processing consultants and analysts, has occupied new, 20,000-sq.-ft. quarters at 8115 Fenton St., Silver Spring, Maryland.

Representatives Named

Dyna Reps, Fort Worth, Tex., has been appointed technical sales representative in Texas, Oklahoma, Arkansas, and Louisiana for Jordan Electronics, a division of The Victoreen Instrument Co. of Alhambra, Calif. Jordan's product line includes solid-state power supplies, timing controls, sensors, and subsystems. . . . *Robert O. Whitesell and Associates, Indianapolis, Ind., has been appointed Indiana-Ohio-Kentucky area representative for Kinetics Corp., Solana Beach, Calif., manufacturer of electronic and electromechanical aerospace equipment. Other Whitesell and Associates offices are located in Fort Wayne, Cincinnati, Dayton, Cleveland, Columbus and Louisville.* . . . Mr. Dan Q. Jackson, Orlando, Fla., has been named southeastern area representative for Allan Aircraft Supply Co. of North Hollywood, Calif. Allan manufactures AN, MS and other precision hydraulic fittings, specializing in stainless steels and exotic alloys.

In the Courts

A Federal district court in New Jersey has ruled in favor of Aerojet-General Corp. in a suit for infringement of its trade mark rights by the American Oil and Supply Co. of Newark, N.J.

Aerojet claimed the first of its registrations of the trade mark, "Aerojet," with the US Patent Office had been in 1944. Its complaint alleged that the Newark firm had subsequently registered and used "Aerojet" as a trade mark for lubricants it marketed for jet aircraft engines and turbines.

Aerojet's suit asked that the defendant be enjoined from further use of the trademark.

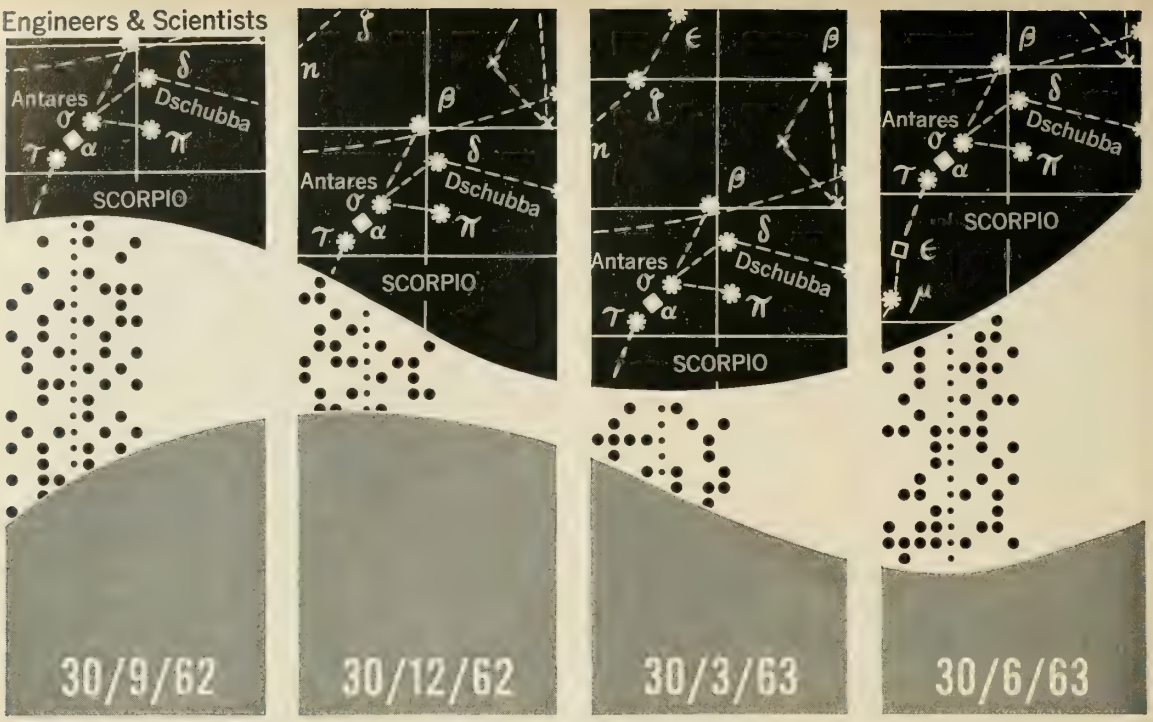
The court ruled Aerojet-General's trade mark registrations were valid and permanently restrained the defendant from use of the mark. It also ordered the US Patent Office to cancel the oil company's trade mark registration, and directed destruction of all signs, labels, wrappers and other materials using the "Aerojet" trade mark.

In another case, Ampex Corp., Redwood City, Calif., electronics firm, has filed suit in San Francisco Federal District Court, charging patent infringement by a firm that was formed by a group of former Ampex employees.

Mach-Tronics, Inc., Mountain View, Calif., was accused by Ampex of patent infringement related to techniques incorporated in the Videotape television recorder. Ampex contends that it invented the Videotape recorder; that it invested over $11 million in its development; and that a recorder being developed by Mach-Tronics now incorporates features of the Ampex machine.

An earlier Ampex charge of illegal appropriation of trade secrets against Mach-Tronics is now combined with the patent infringement action. In response to the earlier charge, Mach-Tronics filed an antitrust action against Ampex.

Engineers & Scientists



digitizing a star almanac

for missile and spacecraft navigation

Many advanced concepts and techniques — aimed at lifting the state-of-the-art in stellar-inertial systems — are under study at General Precision Aerospace. Among them is the feasibility of a microminiaturized digital computer memory, covering position references of selected stars, hour by hour, throughout the year.

THIS EXCEPTIONAL COMPETENCE IN STELLAR-INERTIAL SYSTEMS ... can further your career substantially

General Precision Aerospace is one of three firms in the country with full, in-house capability to design, develop and provide systems management for *complete* celestial-inertial guidance and control systems. It offers qualified engineers and scientists an outstanding opportunity to gain high professional competence in an advanced area of missile and spacecraft technology ... and to grow with a growing organization.

OVER 160 NEW POSITIONS CREATED BY CONTRACT BACKLOG INCLUDING MMRBM PROGRAM

The Systems Division is engaged in a major new program to provide stellar-inertial guidance for MMRBM, the Mobile Mid-Range Ballistic Missile. Other efforts are currently concentrated in the following areas: Guidance and Control Systems for Missile and Space Vehicles; Aerospace Ground Support Equipment Systems; Aerospace Tracking and Detection Systems; Airborne Command and Control Systems.

YOUR INQUIRIES ARE INVITED REGARDING THESE OPENINGS:

AEROTHERMODYNAMICS ENGINEER
Supersonic aerodynamics and thermal analysis applied to ballistic missiles. Some knowledge of hypersonics and space environments desirable.

THERMAL SYSTEMS ENGINEER
Heat transfer and systems analysis on missile and space vehicle structures and skins. Familiarity with thermal effects on electronic or guidance and control equipment desirable.

SPACE ENVIRONMENT/POWER SOURCE – ENGINEERS
Specialists to analyze vehicle compartment environments and design state-of-the-art air conditioning and power systems. A) experience in vacuum – acoustics or B) experience in solar energy, battery, thermo, nuclear, electrostatic space power sources.

ELECTRO-OPTICAL SYSTEMS ENGINEERS
Evolve and specify systems such as star sensors, horizon scanners, and solar sensors. Prefer E. E. familiar with IR sensors and associated circuit techniques. Optical systems background desired.

SYSTEMS ANALYSIS AND SYNTHESIS – SR. STAFF ANALYSTS
Analytical work in areas of feedback control and inertial guidance systems at concept stage where guidance equations, systems evaluation and dynamic performance of guidance steering loops are to be studied.

MISSILE FLIGHT CONTROL ENGINEERS – ADAPTIVE/OPTIMAL
Original analysis and systems design of unique systems for missile and space vehicles. Will work closely with inertial guidance systems engineers to tie in flight control; integrate equipment for associate and subcontractors and insure operational reliability.

INERTIAL GUIDANCE SYSTEMS – PROJECT MANAGERS
Comprehensive knowledge of inertial or hybrid-inertial systems to determine optimum systems parameters and configurations, specify and integrate stable platform, gyros, star trackers, and computer sub-systems into state-of-the-art stellar-inertial guidance systems for a mobile ballistic missile.

DIGITAL SYSTEMS ENGINEERS – MANAGERS & ENGINEERS
Analyze systems requirements and prepare specifications to sub-contractors for air/space-borne computers of state-of-the-art nature.

SUBSYSTEMS SPECIFICATIONS – TECHNICAL LEADER
Analyze systems requirements and prepare spec packages for distribution to associate and sub-contractors.

ADVANCED PROGRAMS – PROGRAM MANAGERS AND SR. STAFF ENGINEERS
A newly formed Branch of our Aerospace Systems Division is being staffed at senior levels and requires talented technical and managerial candidates who will be concerned with our product line of the future. Areas now requiring additional key engineers are: Advanced Systems R&D – Aerothermodynamics – Electronics and Communications – Astro-dynamics – Structures and Materials – Astro/Aerospace Physics – Applied Math and Computing – Reliability – Human Factors – Advanced Systems Requirements and Development – Guidance, Computer, Control and Radiation Systems Engineering – Systems Integration – Mechanical Systems.

Write in confidence to Mr. Paul Kull, Dept. 13-D General Precision Aerospace, Little Falls, N.J.

GENERAL PRECISION AEROSPACE
GENERAL PRECISION, INC.

KEARFOTT DIVISION
GPL DIVISION
SYSTEMS DIVISION
RESEARCH CENTER

An Equal Opportunity Employer

Circle No. 20 on Subscriber Service Card

AWARDS

AIR FORCE

$23,462,938—**Boeing Co.,** Seattle, for follow-on research and development for the *Minuteman* weapon system. Work to be done at Patrick AFB.

$9,000,000—**Boeing, Co.,** Seattle, for continued development work on the *X-20 (Dyna-Soar)*.

$8,078,119—**System Development Corp.,** Santa Monica, Calif., for development and preparation of system training programs.

$5,100,000—**Martin Marietta Corp.,** New York City, for research and development work on the manned launch vehicles for the *Gemini* program. Work to be done at Baltimore.

$3,500,000—**Boeing Co.,** Seattle, for work on the *Minuteman* weapon system. Work to be done at Seattle and at Vandenberg AFB.

$2,900,000—**Marquardt Corp.,** Van Nuys, Calif., for major expansion of facilities at the Air Force Jet Laboratory, in support of the advanced aerospace propulsion program. Work to be done at Ogden, Utah.

$2,500,000—**General Precision, Inc.,** Tarrytown, N. Y., for continued development of a stellar inertial guidance system. Work to be done at Little Falls, N. J.

$2,400,000—**Philco Corp.,** Philadelphia, for work on control subsystems for space programs. Work to be done at the Western Development Laboratories, Palo Alto, Calif.

$2,360,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space subsystems. Work to be done at Sunnyvale, Calif.

$2,298,865—**General Motors Corp.,** Detroit, for provision of airborne and ground equipment in support of *Titan II* guidance subsystems. Work to be done at Milwaukee.

$2,200,000—**Martin Marietta Corp.,** Baltimore, for *Titan I* facility and checkout at bases in Wash., S. D., Idaho and Calif.

$2,000,000—**General Dynamics Corp.,** New York City, for development, verification and delivery of technical manuals and related equipment for *Atlas* missiles. Work to be done at San Diego, Calif.

$1,979,960—**General Dynamics Corp.,** New York City, for research, development, test and fabrication of *Atlas* missiles. Work to be done at San Diego, Calif.

$1,800,000—**General Dynamics Corp.,** New York City, for increased space propulsion system work. Work to be done at Kirtland AFB, N. M.

$1,800,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for continued work on space subsystems.

$1,587,231—**Hallicrafters Co.,** Chicago, for work on a classified project.

$1,316,480—**Bendix Corp., Eclipse-Pioneer Div.,** Teterboro, N. J., for equipment to be used in the *Minuteman* missile's inertial guidance and control system.

$1,200,000—**Avco Corp.,** Wilmington, Mass., for continued work on *Minuteman* re-entry vehicles.

$1,138,600—**Jen-Mar Construction Co.,** San Diego, Calif., for construction of on-base technical support facilities for the *Minuteman* Wing V at Francis E. Warren AFB, Cheyenne, Wyo.

$1,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space satellites.

$1,000,000—**Hercules Powder Co.,** Wilmington, Del., for production of Stage III *Minuteman* motors.

$398,000—**E. I. du Pont de Nemour Co., Inc.,** Wilmington, Del., for synthesis of high-energy solid-oxidizer binder propellants.

$50,000—**Exotech, Inc.,** Alexandria, Va., for a feasibility study of IR detection of meteoroid puncture of *Atlas* missile tanks.

Curtiss-Wright Corp., Wood-Ridge, N. J., for an investigation of "slender channel" electrogasdynamics (EGD) (undisclosed amount).

Materials Research Corp., Orangeburg, N. Y., for development of improved methods for the transfer and flow control of cryogenic liquids used in space applications (undisclosed amount).

Thiokol Chemical Corp., Bristol, Pa., for the development of large solid-fuel boosters (three contracts—undisclosed amount).

ARMY

$1,890,811—**Sperry-Rand Corp., Sperry Utah Co. Div.,** Salt Lake City, Utah, for engineering services in connection with the production of *Sergeant* missile.

$365,000—**AiResearch Mfg. Co.,** Phoenix, Ariz., for electric propulsion systems.

$151,000—**Raytheon Co.,** Andover, Mass, for *Hawk* missile system repair parts.

$134,900—**ITT Federal Laboratories,** Nutley, N. J., for prototype *Army II* satellite.

$102,000—**Western Electric Co.,** New York City, for continued research and development on the *Nike-Zeus* missile system.

NAVY

$5,000,000—**General Dynamics Corp.,** Pomona, Calif., Div., for increased funding for *Terrier* and *Tartar* missile guidance control units.

$1,584,756—**General Precision, Inc., Librascope Div.,** Glendale, Calif., for fire-control systems for submarines.

$1,500,000—**American Machine and Foundry Co.,** Brooklyn, N. Y., for *Bullpup* missile rocket engine.

$500,000—**Vitro Corp. of America,** Silver Spring, Md., for additional system engineering and supporting services for the *Tartar* missile weapon system.

$370,800—**Ling-Temco-Vought, Inc.,** Dallas, for technical supervision to *KD2U-1* target drone operations.

$214,000—**Vitro Corp. of America,** Silver Spring, Md., for research and development on launching systems for guided missiles and antisubmarine warfare weapons.

NASA

$195,000,000—**McDonnell Aircraft Corp.,** St. Louis, for fabrication on *Gemini* spacecraft.

$7,800,000—**Ets-Hokin & Galvan, Inc.,** San Francisco, for Phase II construction of Integrated Mission Control Center, Manned Spacecraft Center, Clear Lake, Tex.

$325,000—**Martin Co., Denver, Colo., Div.,** for study contract on feasibility of adapting the *Centaur* upper-stage vehicle to the *Titan II* booster system.

$80,000—**Fairchild Stratos, Electronics Systems Div.,** Wyandanch, N. Y., for a feasibility study of F-S digital electronic continuous ranging altimeter to *Saturn* vehicle.

$78,000—**Lockheed Propulsion Co.,** Redlands, Calif., for a study of flight-weight propulsion system using advanced hybrid propellants.

U.S. ARMS CONTROL & DISARMAMENT AGENCY

$158,500—**Bendix Corp., Systems Div.,** Ann Arbor, Mich., for evaluating techniques designed to detect violations of an agreement limiting the production of strategic delivery vehicles.

ATOMIC ENERGY COMMISSION

$167,000—**Martin Co., Nuclear Div.,** Baltimore, Md., for design of a 40-watt radioisotope electrical system for IMP (Interplanetary Monitoring Probe) satellites.

$74,000—**Martin Co., Radioisotope Production Facility,** Quehanna, Pa., for development of a strontium fuel for future space use.

INDUSTRY

$3,100,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., from **Martin Marietta Corp.,** for *Titan III* attitude control system.

$1,000,000—**Ling-Temco-Vought, Inc.,** Dallas, Tex., from **Chrysler Corp.,** for production of first stage *Saturn* booster fuel and oxidizer containers.

$250,000—**International Pipe and Ceramics Corp.,** Los Angeles, Calif., from **Raytheon Mfg. Co.,** for further production of ceramic radomes for use on the *Sparrow III* missile.

$195,000—**Aerospace Electronics, Inc.,** Miami, Fla., from **Tool Industries of Florida, Inc.,** for the manufacture of special purpose cable assemblies for the *Pershing* program.

$170,000—**Schaevitz Engineering,** Pennsauken, N. J., from **General Dynamics/Pomona,** for production of accelerometers for use on a major missile program.

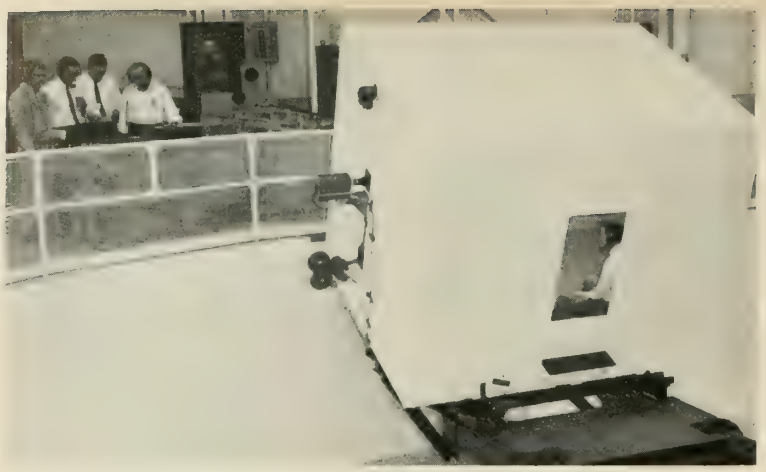
$140,000—**Pacific Semiconductors, Inc.,** Lawndale, Calif., from the **Boeing Co.,** for electronic diodes for the *Minuteman* weapon system.

$120,000—**Ryan Aeronautical Co.,** San Diego, Calif., from the **Boeing Co.,** for *Minuteman* interstage components.

$60,000—**Washington Iron Works,** Seattle, from the **Boeing Co.,** for provision of parts for emergency antenna system for the *Minuteman* weapon system.

Basler Electric Co., Highland, Ill., from **Unidynamics Div. of Universal Match Corp.,** for production of the electrical system for the *Pershing* missile erector-launcher being built by Unidynamics (undisclosed amount).

Lear Siegler, Inc., Instrument Div., Grand Rapids, Mich., from **McDonnell Aircraft Corp.,** for design and building linear scale environmental indicators for the *Gemini* spacecraft (undisclosed amount).



ENGINEERS & SCIENTISTS

At Grumman, **many advanced laboratory and test facilities enable our engineers and scientists to subject new theories and designs immediately to comprehensive experimental verification. Shown above, Bruce Kleisler, Structural Test Engineer (joined Grumman in '59), Dr. Joseph Lisa, Physiologist (joined Grumman in Mar. '63), Kenneth Lee, Supervisor of Structural & Environmental Test Lab (joined Grumman '34), Joseph Szymanski, Lead Man—Environmental Test Lab (joined Grumman '51), and Bill Wenzel, Physicist (joined Grumman in '58), are responsible for the construction and the operation of Space Station Simulations.**

This is but a small part of the up-to-the-minute equipments currently available at Grumman. To engineers and scientists who are hamstrung by inadequate facilities and who recognize that their full potential can only be realized when they are given the tools to do the job, Grumman offers a new horizon for professional advancement. Those seeking such an empirical environment will find responsible positions immediately available on advanced space programs.

Space Power Engineers—EE or Physicist with understanding of electrical energy generation, thermodynamics and preferably some knowledge of direct conversion of electrical energy from heat and solar energy. To analyze and compare sizes, weights, efficiencies of various means of obtaining electrical energy from solar, nuclear and chemical energy; to perform preliminary design of secondary power systems for satellites and space vehicles; to participate in hardware development programs.

Navigation & Guidance Engineers—BS in Engineering with a minimum of 3 years experience in Navigation and Guidance systems. Should be experienced in real system and component hardware including analysis, system synthesis, performance and test in aerospace applications.

Stabilization & Control Systems Engineer—BS in Engineering with a minimum of 3 years experience in stabilization and control systems. Should have experience in the analysis, hardware, performance, test, application and interfaces of inertial platforms in aerospace applications.

Aerospace GSE Structural Designers—BS in ME, AE or CE with a minimum of 3 years experience in layout and design. Must be familiar with specifications and materials required for the design of cabinets, racks, frames, chassis and packaging of Aerospace Ground Support equipment. Must be capable of performing preliminary structural analysis and coordination of design with Manufacturing Department.

Structural Designers—BS in ME, CE, AE or equivalent with a minimum of 5 years experience in layout and design. Familiarity with materials and fabrications for space vehicles, and hydrofoil boats. Ability to perform preliminary structural analyses and coordinate priority structure with manufacturing and purchasing departments. Openings also available in preliminary design for experienced creative structural designers.

Energy Absorption Engineers—BS in ME with 5 years experience in aerospace landing gear design. Duties: Establish the configuration of Lunar Landing System; study and establish landing energy absorption requirements; study and establish the energy absorption medium compatible with space and lunar environment; design lunar landing systems and establish test requirements for the system in space and lunar environment; design for stowage, extension and erection of the system for space and lunar environment.

Senior Heat Transfer Engineers—BS or MS with minimum of 5 years training and experience in structural heat transfer analysis is required. Will develop IBM programs and other analytical tools as needed to handle complicated configurations and end condition for space vehicle structures and propulsion systems. Must be capable of determining temperature distributions and recommended heat transfer configurations for initial structural designs and the detailed analyses, and test verification work to complete the design.

To arrange a mutually convenient interview, send your resume to Mr. A. M. Williams, Technical Staff Engineer, Dept. 86

GRUMMAN
AIRCRAFT ENGINEERING CORPORATION
Bethpage · Long Island · New York
(An Equal Opportunity Employer)

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Supply Department
Naval Air Engineering Center
Philadelphia 12, Pa.

Negotiations will be conducted with Lambert Engineering Co., 1100 Mackland Ave., St. Louis 120, Mo., for services to conduct a design study of an under-the-seat rocket motor pack for the H-5 seat. Award will be made on the basis of an unsolicited proposal by this firm. RFP 156-20439-63Q. This notice is for information purposes only.

National Aeronautics and Space Administration
Wallops Island Station
Wallops Island, Va.

Services and materials for expansion of paging and countdown system. Job—IFB P-630. Bid opening 5-17-63. Bidders are requested to visit the site. Call Mr. M. C. Saunders at VAlley 4-3411, Ext. 273 for appointment.

Atlas Procurement Div.
Guidance Branch
SBAMA
Norton Air Force Base, Calif.

Necessary engineering and services including but not limited to: maintenance and Air Force approved modification of test articles, drawings and design data to support a program for the *Atlas* (SM65) series "D" Burroughs digital computer, a part of the radio guidance system; submission of detailed technical valuations thereon, and other supporting services as required. This was developed by the Burroughs Corp., Detroit, Mich. Plans, specs, data and drawings are not available at SBAMA. Notice is given that the required services must be obtained from the original manufacturer in order to secure safe, dependable and effective operation of Atlas weapon system. This notice is for information purposes only. RFP not available. A proposal is being requested from the Burroughs Corp. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firm. RFP 04-607-63-608.

Atlas Procurement Div.
Guidance Branch
SBAMA
Norton Air Force Base, Calif.

Engineering and services including, but not limited to: integration and coordination connected with engineering problem evaluation and solution; drawing and design data; investigation and resolution of design and interface problems; reliability, feasibility and design improvement studies; analysis of failure reports and other supporting engineering services as required to conduct a program of in-service engineering for interfacing *Atlas* (SM-65) re-entry vehicle system, which was developed by General Electric Co., Philadelphia, Pa. Plans, specs, data and drawings are not available at SBAMA. Notice is given that the required services must be obtained from the original manufacturer in order to secure safe, dependable and effective operation of *Atlas* weapon. RFP 04-607-63-614. This notice is for information purposes only. RFP not available. A proposal is being requested from General Electric Co. It is suggested that small business firms or others interested in subcontracting opportunities make direct contact with the above firm.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston 1, Tex.

Purpose gyro test table and general purpose gyro electronics—1 each. RFP MSC 63-442P. Deliveries to be made FOB Ellington Air Force Base, Tex. Bid opening 5-6-63. Interested parties contact R. C. Liounis, Houston, Tex., WA 8-2811, Est. 7265 thr 7268.

X-ray diffraction and spectroscopy unit. Deliveries to be made FOB Ellington Air Force Base, Tex. RFP 63-526P. RFP due date 5-7-63. Interested parties contact R. C. Liounis, Houston, Tex., WA 8-2811, Ext. 7265 through 7268.

Circle No. 21 on Subscriber Service Card

How Grinnell Primac® Fire Control Systems* provide milliseconds-fast fire protection for dangerous combustibles



1. Photosensitive cell detects fire



2. Electronic control receives signal



3. Primac valve is instantly triggered

When you work with dangerous combustibles — solid propellants, for example — your fire protection must be ultra-fast. Grinnell Primac Fire-Control Systems provide this protection.

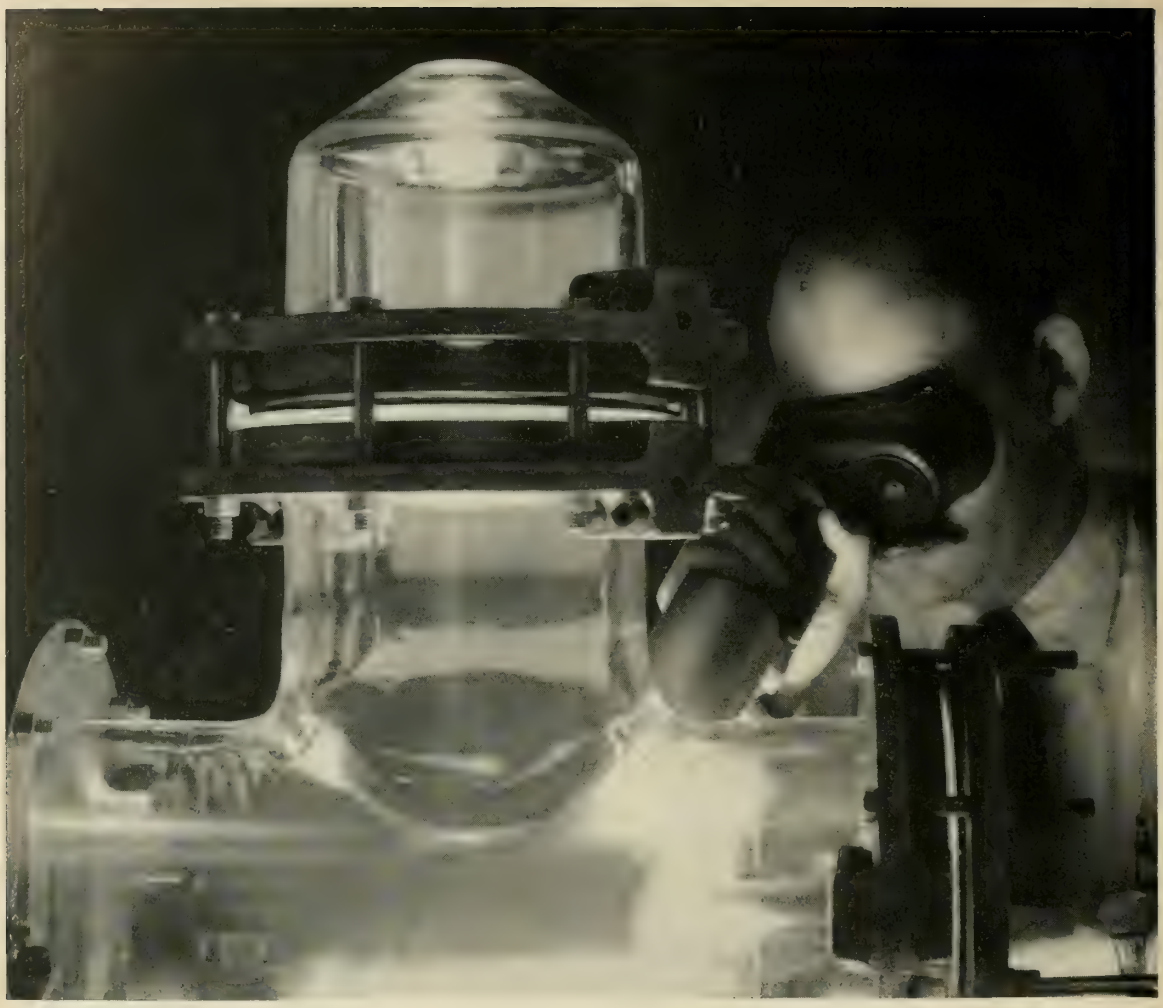
With a Grinnell Primac System, strategically-located photosensitive cells detect the first flash of flame. An electronic panel signals the Primac® valve which instantly releases a deluge of water spray onto the fire. Protective action is in milliseconds . . . thoroughly effective!

Whatever your fire protection or piping needs — special hazards systems, hangers, valves, prefabrication, piping accessories — you can depend on Grinnell. Eight plants . . . nationwide service and supply . . . over 100 years of leadership. Grinnell Company, Inc., 277 West Exchange St., Providence, R. I.

*U.S. Pat. No. 3064739



Circle No. 22 on Subscriber Service Card



Advanced Energy Conversion

... a new field of research at Curtiss-Wright

Nuclear energy holds the future of electric power generation and propulsion, but how near is that future?

Nearer than generally supposed—for at the Advanced Energy Conversion Laboratory of the Wright Aeronautical Division of Curtiss-Wright, research and development have been guided by *feasibility*.

To that end, Curtiss-Wright scientists assayed scores of theories and methods. Three, with unique techniques developed in the Advanced Energy Conversion Laboratory, offer the greatest promise of economical, efficient, reliable, broadly useful electric and propulsive power for Government, Industry and Science: **Magnetogasdynamics**-using low density, cool plasma. **Electrogasdynamics**-using high density, electrically charged gases. **Plasma cells**-using thermally ionized plasma.

Applications seem almost limitless. To mention only a few that are under investigation at Curtiss-Wright: silent submarine energy conversion; vacuum pumping; atmospheric devices for lifting and hovering; closed cycle devices for propelling spacecraft up to satellite orbit velocity and beyond; terrestrial and extra-terrestrial power supplies.

If Curtiss-Wright research in advanced energy conversion seems relevant to your own power or propulsion requirements, we welcome your inquiry.

Wright Aeronautical Division

CURTISS-WRIGHT CORPORATION

Main and Passaic Streets Wood-Ridge, New Jersey

Circle No. 23 on Subscriber Service Card

Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Design optimization of vehicle structure as a meteoroid barrier. Work will involve design work on structure fabrication of cross-sections and testing them with hypervelocity guns. Offerors must meet following minimum conditions: (A) Must have an existing hypervelocity impact testing facility capable of velocities of 12,000 ft./sec. minimum. (B) Must have experience with above facility. (C) Must have capability to produce a preliminary structural design of cryogenic propulsion module. Job—RFP APO-2034. RFP due date approximately 5-16-63. The following sources will be solicited: Aerojet-General Corp., Cleveland, Ohio; The Boeing Co., Seattle, Wash.; General Dynamics Corp., San Diego, Calif.; Beech Aircraft Corp., Wichita, Kan.; Technical Operations, Inc., Burlington, Mass. For information concerning this procurement please contact F. W. Hoffman.

National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Study to determine feasibility of using charge amplifiers for acquisition of acoustic, vibration and shock data during launches from launch complex 39. Environmental measuring program for LC-39 is anticipated to exceed 400 vibration channels. Job—RFP Q-44-3. Contact Mr. Byron Driskill, Telephone 305, 783-8132. RFP due date 5-15-63.

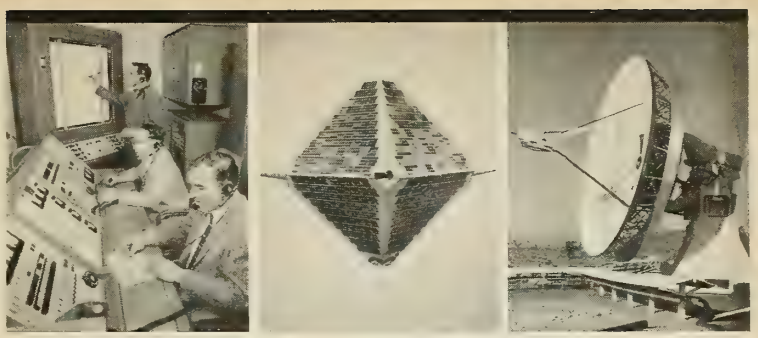
Microwave, two-terminal system consisting of receiver, transmitter and associated equipment with the following general specs: Frequency: 7125-8400 MC (exact operating frequency 7173 MC). Frequency response: 60 cycle to 7 MC plus 5 DB. Channels required: video, 1 each; audio, 2 each. Operating range: normal, 30 miles. Pre-Emphasis: none. De-Emphasis: none. Power requirement: 117 VAC (nom), 60 CPS. Ambient temperature range: 0 deg. C, 55 deg. C—1 each. IFB CC-238-3. Bid opening 5-22-63. Contact Bid Officer, Mr. D. S. Phelps, Phone 305, 783-8232.

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Study and evaluation of known modulation technique in multiple access applications. Job—RFP 42187. RFP due date 5-10-63. The following firms have been invited to participate: Adcom, Inc., Cambridge 42, Mass.; Lenkurt Electronic Co., Inc., 1105 County Road, San Carlos, Calif.; Sylvania Electronic Products, Inc., 1120 Connecticut Ave., N. W., Washington, D. C.; Space Technology Labs, Inc., One Space Park, Redondo Beach, Calif.; Page Communications, Inc., 2001 Wisconsin Ave., N. W., Washington, D. C.; Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.; Jansky & Bailey, 1339 Wisconsin Ave., N. W., Washington, D. C.; Radio Corp. of America, Front and Cooper Sts., Camden, N. J.; Hughes Aircraft Co., Florence and Teale Sts., Culver City, Calif.; Raytheon Co., Executive Office, Lexington 73, Mass.; Welex Electronics Corp., 1000 16th St., N. W., Washington, D. C.; Loral Electronics Corp., 825 Bronx River Ave., New York 72, N. Y.; Cooke Engineering Co., 735 Northeast Asaph St., Alexandria, Va.; Aero Geo Astro Corp., P. O. Box 1082, Alexandria, Va.; Cutler-Hammer, Inc., Airborne Instrument Laboratories, Deer Park, L. I., N. Y.; Hazeltine Corp., 59-25 Little Neck Parkway, Little Neck, N. Y.; Aeronca Mfg. Corp., Aerospace Div., Hilltop and Frederick Roads, Baltimore 28, Md.; Systems Planning and Research Corp., 979 Rollins Ave., Rockville, Md.; The Martin Co., Aerospace Div., Friendship International Airport 40, Md.; Garrett AiResearch Corp., Los Angeles 9, Calif. It is suggested that small business firms and others interested in subcontracting opportunities make direct contact with the above firms. Please do not contact NASA/GSFC on subcontracting inquiries.

National Aeronautics and Space Administration
Headquarters, Procurement Branch
Washington, D. C.

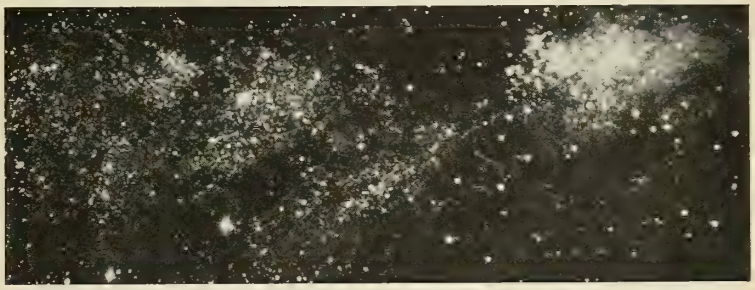
NASA contemplates negotiating a contract with the Sylvania Electronic Systems Applied Research Laboratory in Waltham, Mass., based on their unsolicited proposal for a program definition study for a satellite data collection system. This notice is for information only.



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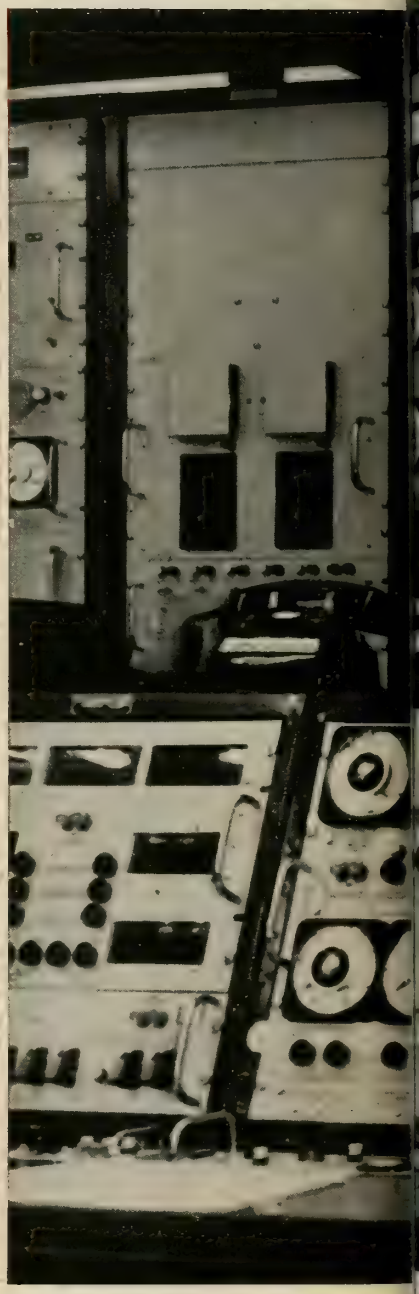
On May 20, MISSILES AND ROCKETS will publish its Special Electronic Report covering Test and Checkout equipment.

As the state-of-the-art advances, Test and Checkout equipment becomes even more important to future space successes. During the past year there have been dramatic advances in this area but much remains to be done by industry and government.

MISSILES AND ROCKETS, the Weekly of Space Systems Engineering, will provide in-depth reports on . . .

- The Test and Checkout Equipment Market, trends through 1970 for equipment research and development and procurement.
- Equipment requirements for Advanced Missile Checkout/Space Booster Checkout/Space Vehicle Checkout/In-flight Manned Spacecraft Checkout.
- Systems and Major Subsystems for Environmental Testing of Space Chambers/High Vacuum Equipment/Temperature/Pressure/Salinity/Radiation/Shock/Vibration.
- Integrated circuits, a special emphasis section.

This issue will be widely read by over 43,000 paid subscribers to MISSILES AND ROCKETS who are vitally interested in all phases of missile/space activities. The May 20th issue is a prime advertising opportunity.



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One big systems field known only to a handful of engineers

(...outside of PAN AM's Guided Missiles Range Division)

We're referring to the new technology—advanced range systems engineering—as developed and practiced by GMRD.

From the systems viewpoint, a striking metamorphosis has taken place since 1953 when GMRD undertook range engineering, operation and development at Cape Canaveral for the Air Force.

A comparatively simple set-up existed in the early '50's (to monitor missile flights up to 500 miles). **Today** this has been transformed into a vast, integrated systems complex of new generation tracking, monitoring, data handling, data support and communications sub-systems.

Present range capabilities can support the launch of global flights; lunar and interplanetary space probes. **New** capabilities are under development now—to meet the unprecedented requirements of the Apollo Program. And GMRD's Advance Planning Group is engaged in projecting range needs as far ahead as the late '70's.

In fact the giant range system at Cape Canaveral and down-range is always a **system-in-transition**, calling for the highest technical contributions from engineers and scientists of many disciplines, to keep pace with the needs of the nation's new missile systems and space vehicles.

YOU ARE INVITED TO INQUIRE ABOUT CAREER OPPORTUNITIES FOR:

Systems Engineers—EE's, Physicists capable of assuming complete project responsibility for new range systems.

Instrumentation Planning Engineers—EE's, Physicists to be responsible for specific global range instrumentation concepts.

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Experience in one or more of these areas: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, underwater sound, timing, shipboard instrumentation.

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Dept. 56D-5

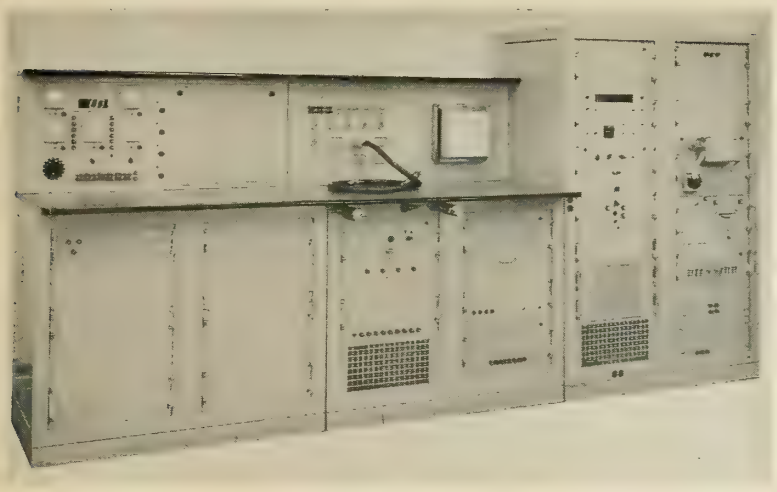
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Circle No 24 on Subscriber Service Card



New Product of the Week:

Automatic Checkout System

An automatic checkout system has been developed by Northrop Nortronics for factory production and field maintenance use.

Satico SP-8 is designed to speed testing, to improve quality in manufacturing operations and to reduce the flow time of spare parts in maintenance work.

The unit operates automatically, semi-automatically, and manually, and is divided into three units corresponding to the modes of operation so that the system can be tailored to a particular requirement. The system measures and evaluates performance of the equipment being checked and provides a visual readout and printed record of test results.

Circle No. 225 on Subscriber Service Card

Aerospace Chemical

A chemical composition said to provide smoother take-off, shorten take-off and landing distances, and help to reduce turbulence of airplanes, missiles and rockets at low speeds, is available from Merix Chemical Co.

Called 7 MAG, the chemical reportedly also reduces skin friction, thereby increasing speeds and flight distances without requiring additional thrust. The non-flammable substance is applied to the outer skin of a rocket or aircraft by wiping, Merix reports.

Circle No. 226 on Subscriber Service Card

Speech Compression System

Melpar, Inc., has received a patent for a speech analyzer and synthesizer that will make possible simultaneous transmission of 20 speech messages over the channel capacity formerly required for one. This is achieved by the removal from the speech message of inefficiently utilized communications space.

The system is expected to find applications in spectrum conversation, coded communication of speech and, in long range, speed communication for manned spacecraft.

The system digitizes speech and transmits it in the form of compressed speech signals, which, when received, are electronically simulated into speech.

Circle No. 227 on Subscriber Service Card

Capacitance Bridge

Boonton Electronics Corp. is marketing a capacitance bridge to measure the frequency continuously adjustable from 5 to 500 kc.

The three-terminal unit contains an oscillator, multi-stage tuned detector, and power supply.

The signal level across the test is continuously variable from a maximum of 3 v to a minimum of 10 mv.

Circle No. 228 on Subscriber Service Card

Research Voltmeter

Developed by The Singer Mfg. Co., the Model ATV is an rms voltage measuring standard, designed primarily for the calibration of ultra high frequency voltmeters.

The unit is an adjustable waveguide-below-cutoff attenuator. RF power is coupled to a UHF vacuum thermoelement by the output electrode. The resolution of the Model ATV is 0.0001 in. per division without reading the vernier.

In operation, the micrometer is adjusted to produce a standard reading on a millivoltmeter. An exact voltage is obtained by referring the micrometer setting to the calibration chart for the frequency being used.

Circle No. 229 on Subscriber Service Card

Crossbar Scanner

James Cunningham, Son & Co., has developed a crossbar scanner, the SQ 10K/1, offering up to 10,000 channels and up to 10 wires per channel.

The control unit of the system utilizes semi-conductor circuitry mounted on printed circuit cards for all logic and crossbar actuator control.

The heart of each 1000-channel one-wire SQ 10K/1 crossbar module is a F20x10x6 crossbar switch. The chassis is mounted, with inputs facing up, on ball-bearing slides, an arrangement which allows ease of access to the crossbar input terminations.

Circle No. 230 on Subscriber Service Card

Impedance Rectifiers

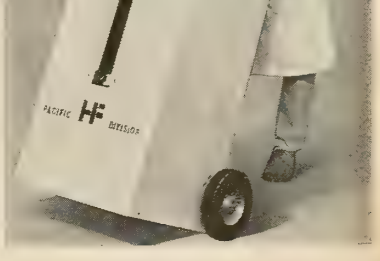
An all-welded, insulated-stud silicon rectifier series with low thermal resistance construction has been developed by General Instrument Corp., Rectifier Div. The series RA 1000 through RA 1006 operates at 150°C case temperature and can withstand 200°C storage temperatures.

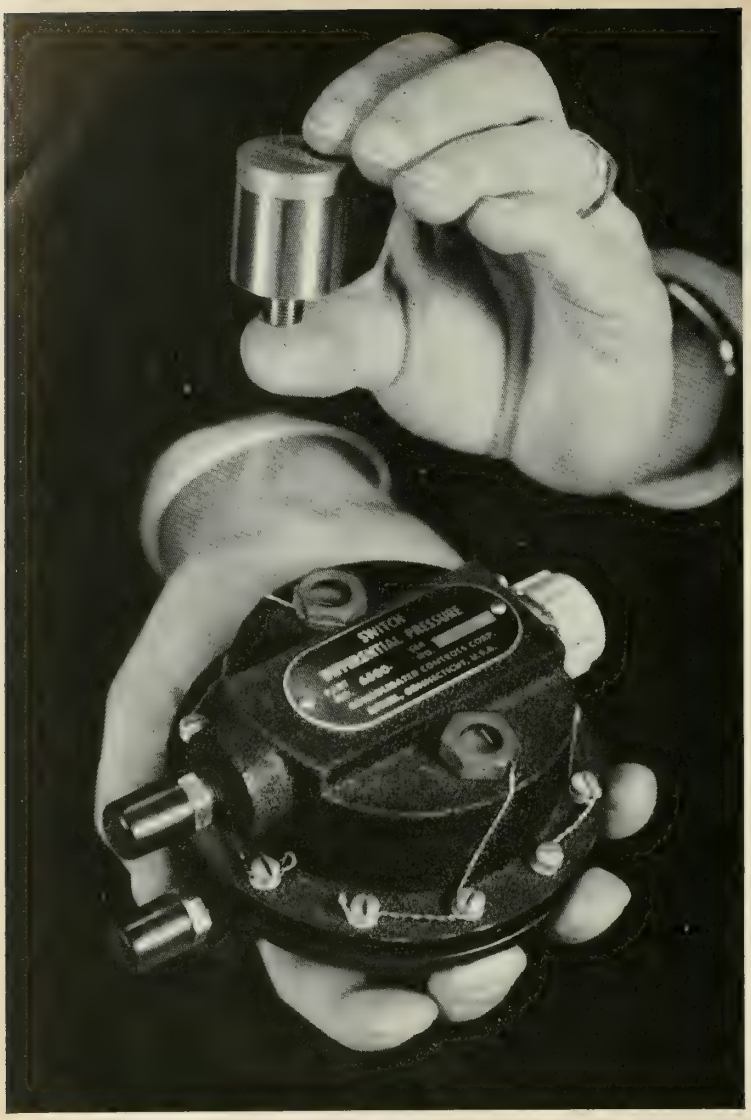
Circle No. 231 on Subscriber Service Card

Portable Dehydrator

A portable fluid filter and dehydrator—for clean-up of test equipment actuated by hydraulic systems—is being marketed by Pacific Div. of Houston Fearless Corp.

Particulate contaminants as small as





How small can a pressure switch be?

A lot depends on the requirements. The pressure range, the accuracy required, the differential between make or break, the contact rating, and the connections. ■ But a whole lot more depends upon the ability of the manufacturer. Consolidated Controls has designed and produced more than 300 different pressure switch models covering pressures from 0.4 inches of water to 10,000 psi. ■ Each is designed to be as small and light in weight as is compatible with all the specifications. ■ Chances are, we already have a design that will solve your problem with space to spare. Why not write today giving us the details of your particular switch problem.

Interesting Openings for Control Engineers

CONSOLIDATED CONTROLS CORPORATION

BETHEL, CONNECTICUT

A Member of The Condec Group

Circle No. 29 on Subscriber Service Card

two microns nominal and moisture down to 25 parts per million can be removed from such fluids as Skydrol, Oronite, MIL-H-5606 and MIL-H-6083. Models of the device vary in capacity from 5 to 30 gpm, with or without reservoirs.

Circle No. 232 on Subscriber Service Card

Manometer

An automated mercury manometer with accuracy to 0.0005 in. plus 0.005% of reading has been developed by Schwien Engineering.

The design lends itself to use as an indicator of unknown pressures, or a generator or controller of any desired pressure through a range of 0 to 100 in. of mercury. Continuous temperature compensation to 0.1°F direct digital readout, and a capacitance level gaging null system, which avoids degenerative effects of mercury contamination, are other features.

Circle No. 233 on Subscriber Service Card

Wound-Field Motor

Globe Industries Inc. has available the Type GR motor which has a continuous-duty rating range up to 1/6 h.p. at 8,000 rpm. Used for ground support equipment where universal a-c/d-c operation is required, units can be furnished as series, split series, shunt or split shunt, and in every case the winding is designed to deliver the optimum characteristics desired.

Circle No. 234 on Subscriber Service Card

Rotary Potentiometer

A rotary potentiometer, which has a linearity of 0.01% with infinite resolution, is being marketed by Computer Instruments Corp.

The unit is intended to fulfill the need for the additional requirements of accuracy in the high-speed analog computers used in gunfire control systems and in launching of ground- or ship-to-air missiles.

The accuracy of the Model 505 is determined primarily by the uniformity of film depositions. By means of the introduction of a closed loop-electrochemical film deposition process involving spectrographic sampling continuously during film deposition, the uniformity of the electrical characteristics of the resistor film has been improved.

Circle No. 235 on Subscriber Service Card

Counter System

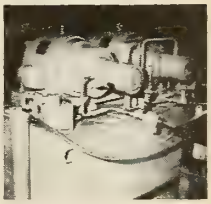
Pulse Engineering Inc. has available a scintillation counter "system package," which includes a ruggedized version of the RCA 4438 phototube, and is optically coupled to a 1-in. x 1-in. sodium



Hydraulic power package lifts the giant Saturn gantry complex before blastoff

October 27, 1961 (10:06 A.M. EST) at Cape Canaveral's Complex 34 marked the successful launching of the first NASA Saturn (C-1) space vehicle. A Denison hydraulic power system played a key role in the ground support phase of the Saturn launching. The unit (two were designed and built by Denison in the near-record short period specified by NASA) pulls the locking pins and raises the huge gantry tower complex onto trucks prior to firing.

Each power unit consists of a 110-gallon, stainless steel JIC reservoir with stainless steel tubing and fittings. And each unit incorporates two 5000 psi Denison Series 600 constant volume axial piston hydraulic pumps plus control console panel.



Your nearby Denison hydraulics specialist will welcome discussing ground support equipment fluid power applications with you at any time. He has complete data on our full line of hydraulic pumps, motors, valves and controls for GSE systems up to 5000 psi. To get in touch with him—and for your free copy of the new 72-page Denison Hydraulic Power Catalog—write, wire or phone us now.

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DENISON ENGINEERING DIVISION • AMERICAN BRAKE SHOE COMPANY • 1214 Dublin Road • Columbus 16, Ohio

Circle No. 26 on Subscriber Service Card

iodide crystal. Both tube and crystal are encapsulated in a system that contains a d-c/d-c converter and a matching low-noise preamplifier with a 50-ohm output impedance. The system also has a temperature compensation network and is protected from shock, vibration, and vacuum.

Circle No. 236 on Subscriber Service Card

Cable & Connector Tester

An automatic cable and connector tester is available from Automation Dynamics Corp. for field or production testing. The ADCO Model 123 automatically sequences each wire, tests resistance, and detects improperly connected wires and leakage between wires. Range switches on the panel permit adjustment of reject values of continuity from 1 to 25 ohms and leakage to 1000 megohms. Hi-pot is adjustable from 100 to 1000 v d-c.

Circle No. 237 on Subscriber Service Card

Hypersensor

Qualtronic Corp.'s solid-state hypersensor is designed for protecting transistors, diodes, meter movements, and other sensitive equipment. It is two-terminal, low-resistant, and reacts to one microsecond current transient in 10 microseconds.

The unit will change resistive state with current transients at a level suitable for protection of most power supplies, etc. It may be placed in base leg of transistor to control currents in ampere range.

Circle No. 238 on Subscriber Service Card

Supersensitive Monitor

A monitoring instrument to detect radioactive airborne plutonium or other long half-life alpha-emitting isotopes has been developed by Nuclear Measurement Corp.

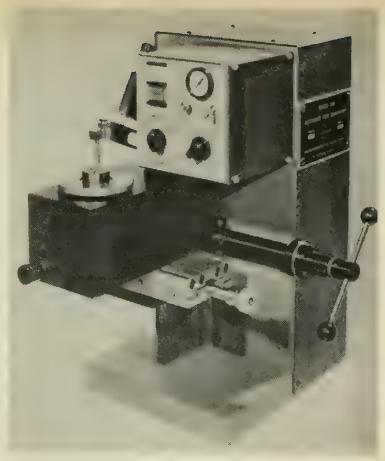
Model PAPM-1 monitors airborne concentrations of plutonium as minute as 5×10^{-13} μc/cc. Continuous and instantaneous protection from bursts of activity is assured by employing two detectors and two collectors. Alternate collection is programmed and detection is continuous. Gross count of long half-life emitters is automatically printed in digital form by the programmed integrating scaler.

Circle No. 239 on Subscriber Service Card

Thin-Metal Seamwelder

An automatic welding machine for sealing thin metal sections has been developed by Nyborg Engineering Corp.

Utilizing a reciprocating electrode and a rotating collet to hold the work piece, the unit automatically places a circle of overlapping spot welds on the



metal membrane to form a true hermetic seal. Weldable metals ranging from 0.005 to 0.015-in. thick may be jointed with the welder, and can be welded to themselves or to heavier metal parts.

Circle No. 240 on Subscriber Service Card

Undersea Thermometer

Westinghouse Electric has available a device to take the ocean's temperature. The unit can pinpoint underwater temperatures to 1/20th of a degree F.

The improved transducer changes electrical pulsations into mechanical vibrations of ultrasonic frequency. It also can reverse the process, converting the mechanical vibrations into electrical pulses.

The transducer contains a disk, 1-in. in dia., which has a natural frequency of vibration of about 40,000 vibrations per second.

Circle No. 241 on Subscriber Service Card

Read-Out and Programming

Nuclear-Chicago has developed the Ultrascaler II, which combines one or two fast decade scalers, an electronic timer, a regulated high voltage supply, and permanent data read-out in a single instrument.

Ultrascaler II provides all standard counting modes, including preset time, preset count, and time/count. Eleven preset counts—up to 1,000,000—can be selected for each scaler, and the timer offers thirteen preset time intervals.

Circle No. 242 on Subscriber Service Card

AC-DC Solenoid Valve

Developed by Parker Aircraft Co., a two-stage, solenoid-operated hydraulic valve for ground support equipment, submarine and marine, operates on both 115 volts a-c and 20 volts d-c without adjustment or coil changes. The device permits operation on regular 60-cycle line current and on emergency or battery power as a single-voltage valve.

Pressure-operated to all positions, positive action overcomes contamination hang-ups encountered with standard spring-return valves. It is available in 12- and 24-gpm sizes at pressures up to 3,000 psi.

Circle No. 243 on Subscriber Service Card

Inverter

Marketed by Engineering Model Lab., Inc., a 2-kw inverter starts ½-hp motors from rest and supplies 2000 watts at unity power factor. Initial applications have been in sidereal and satellite tracking systems. An external 25-volt signal will drive this amplifier fully in the range of 60 cps. Higher frequency capability (400 or 3200 cps) is available.

Circle No. 244 on Subscriber Service Card

Potter/Molder

The "Quail"—a potting and molding machine developed by United Process Machine Co.—is claimed to achieve practical automatic on-off potting with silicones, room-temperature elastomers and filled epoxies, in quantities commensurate with output of 20-600 grams/min. of high-viscosity materials above 50,000 centipoises.

According to United, the metering pumps are specially modified to handle abrasive fillers without seizing; have varying speed drives and a metering accuracy of ±0.5%; and are available for ratios of 1:1 to 100:1. Temperature-controlled pressure reservoirs have close-tolerance proprietary agitators to maintain fillers in suspension and to facilitate de-gassing, the firm says.

Circle No. 245 on Subscriber Service Card

Portable Transient Detector

A portable instrument for monitoring high-frequency transients in electronic/electrical systems is being marketed by Applied Systems Corp.

The Model 2601 is designed to aid test engineers in detecting and eliminating transient impulses which create RFI and reliability problems with transistor electronics.

Impulses as short as 0.1 microsecond in duration can be detected. Adjustable detection levels measure the voltage amplitude of positive or negative transients occurring up to 3,000 per second. High input impedance (9.0 megohms at 2.5 pf) prevents circuit loading. Outputs are provided for recording, counting, printing, or time-correlating transients with system events.

Circle No. 246 on Subscriber Service Card

How many ways can **TRANS-SONICS,** INC. *serve you?*



IN-FLIGHT PERFORMANCE

Optimum flight performance can be realized only through effective propellant measurements — temperature, volume, mass, and pressure. Less than optimum instrument performance ultimately represents a severe limitation on range and payload — with frightening economics.

Optimum propellant measurements can be realized through the systems design experience of Trans-Sonics* engineering team. Its hardware has been proven on the test stand and in-flight: its thinking is based on fourteen previous years in the business — and on the next ten.

Optimum system performance can be realized only through the use of reliable components and sensors — Trans-Sonics builds quite a few! Pressure and temperature transducers, as well as a solid state digital liquid level device, show a continuing appreciation of airborne accuracy and reliability requirements. We submit that's nice experience to have in system design.

Trans-Sonics, Inc. will be glad to discuss propellant measurements with you — for optimum attention to your needs, write, wire, or 'phone Trans-Sonics, Inc., Dept. MR, P. O. Box 328, Lexington 73, Massachusetts, TWX 617 272-0317, BRowning 2-1000.

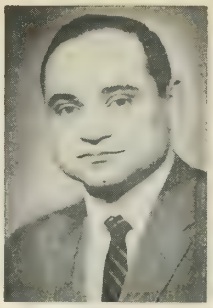
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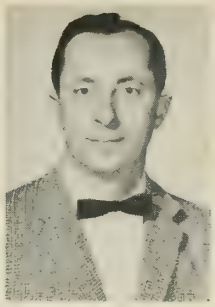
To put the sure in measurement...

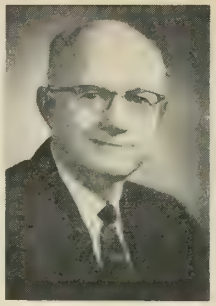
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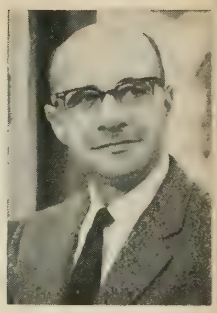
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Dr. Gaelen L. Felt: Appointed chief operating officer and vice president in charge of Edgerton, Germeshausen & Grier, Inc.'s Las Vegas, Nev., laboratories.

Harvey A. Dubner: Appointed vice president of engineering for Simmonds Precision Products, Inc., Tarrytown, N. Y.

John W. Anderson: Named general manager of the newly expanded Aeronautical Div. of Minneapolis-Honeywell Regulator Co., Boston. **J. Chuan Chu** named vice president for planning and engineering. **Robert J. Keeler** named director of engineering.

Samuel Solow: Promoted to chief electronics engineer for General Technology Corp., Torrance, Calif.

H. F. Kinkopf: Appointed sales manager for BIAX computer memories at Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

Charles C. Workman, Jr.: Promoted to director of advanced systems marketing in the International Business Machines Corp.'s Federal Systems Div., Rockville, Md.

Nathaniel B. Nichols: Appointed director, sensing and information subdivision, Technical Div., of the San Bernardino Operations of the Aerospace Corp., San Bernardino, Calif.

James I. Stalker: Appointed manager of manfacturing engineering for the Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif.

Dr. John M. Salzer: Appointed associate director of advanced systems for General Precision, Inc.'s Information Systems Group, Glendale, Calif.

James W. Dunham: Appointed director of marketing of the Bendix Corp.'s Products Aerospace Div., South Bend, Ind.

Frank J. Butteri: Appointed assistant to the general manager of Cubic Corp.'s Industrial Div., San Diego, Calif.

Richard A. Campbell: Appointed vice president-operations development of Thompson Ramo Wooldridge Electronics, El Segundo, Calif. **Thomas M. Fitzgerald** appointed vice president and general manager of TRW's Pacific Semiconductors, Inc.

John Downs: Appointed vice president and general manager of the Melbourne, Fla., division of Instrument Corp. of America.

Robert Shone: Named head of the Photogrammetry Research and Development Dept. at Bauch & Lomb, Inc., Rochester, N. Y.

B. F. "Sandy" Coggan: Appointed vice president-operations of Douglas Aircraft Co., Santa Monica, Calif.

Robert O. Burns: Named corporate director of management systems and organization at Kollsman Instrument Corp., Elmhurst, N. Y.

Lothar Harzdorf: Joined Chaskin-Dimmick Corp.'s Communicom Div., Palo Alto, Calif., as chief network design scientist.

Stanley Rothman: Appointed manager of the Special Development Dept. of System Development Corp., Santa Monica, Calif. **Everett Stone** named manager of the Satellite Control Dept.

Gene P. Hopkins: Elected president of Emtec, Inc., Elyria, Ohio.

James M. Bridgman: Appointed director of corporate industrial relations at Burroughs Corp., Detroit.

Kenneth Archbold: Appointed director of engineering at Delta-f, Inc., Crystal Lake, Ill.

D. M. Tenenbaum: Appointed assistant manager-operations at the Liquid Rocket Plant of Aerojet-General Corp., Sacramento, Calif.

David E. Weiss: Appointed vice president of Servonic Instruments, Inc., Costa Mesa, Calif., in charge of the eastern division, Willow Grove, Pa.

William G. Whitney: Named general manager of programs review at the Martin Co., Friendship International Airport, Md.

Robert W. Reniers: Appointed vice president-sales of the Vard Div. of Royal Industries, Inc., Pasadena, Calif.

EMPLOYMENT

Magnetic Engineer

Electro-mechanical or Electrical Engineer wanted for Esoteric Projects. MSEE preferred. Will consider BSEE. Must have 4 years experience in diminutive mechanical or magnetic devices. Well versed in Design and Calculation. Five figure salary. Relocation allowance. Long-term contract. State complete qualifications, salary expected in first letter.

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—when and where—

APRIL

AIEE Electro-Nuclear Meeting, Richland, Wash., April 29-30.

Instrument Society of America, National Analysis Instrumentation Symposium and Exhibit, Rice Hotel, Houston, April 29-May 1.

American Society of Tool and Manufacturing Engineers, Annual Engineering Conference and Exposition, International Amphitheater and Conrad Hilton Hotel, Chicago, April 29-May 1.

Society of Photographic Scientists and Engineers, Annual Conference, Ambassador Hotel, Atlantic City, N. J., April 29-May 3.

MAY

American Institute of Electrical Engineers, Great Lakes District Meeting, Blackhawk Hotel, Davenport, Iowa, May 1-3.

Third National Conference on the Peaceful Uses of Space, sponsored by NASA, and Committee for Economic and Cultural Development of Chicago, Chicago, May 1-9.

AIAA and Aerospace Medical Assn., Manned Space Laboratory Conference, Statler-Hilton Hotel, Los Angeles, May 2.

Institute of Radio Engineers, National Symposium on Human Factors in Electronics, Marriott Twin Bridges Motor Hotel, Washington, D. C., May 2-3.

American Institute of Chemical Engineers National Meeting, Statler-Hilton Hotel, Buffalo, N. Y., May 5-8.

Aerospace Reliability and Maintainability Conference, sponsored by ASME, SAE and AIAA, Marriott Motor Hotel, Washington, D. C., May 6-8.

Instrument Society of America, National Aerospace Instrumentation Symposium, Jack Tar Hotel, San Francisco, May 6-9.

American Society of Mechanical Engineers, Production Engineering Conference, Netherland-Hilton Hotel, Cincinnati, May 7-9.

Electronic Components Conference, sponsored by AIEE, EIA and IRE, International Inn, Washington, D. C., May 7-9.

National Aerospace Standards Committee of the Aerospace Industries Assn., 60th Meeting, Hotel Roosevelt, New York City, May 8-9.

Society for Experimental Stress Analysis, Spring Meeting, Benjamin Franklin Hotel, Seattle, May 8-10.

American Institute of Chemists Meeting, Warwick Hotel, Philadelphia, May 8-11.

American Institute of Aeronautics and Astronautics and Institute of Radio Engineers, National Aerospace Electronics Conference, Biltmore Hotel, Dayton, Ohio, May 13-15.

Instrument Society of America, National Power Instrumentation Symposium, Hotel Bellevue-Stratford, Philadelphia, May 13-15.

Industrial Research Institute, Semi-Annual Meeting, Fairmont Hotel, San Francisco, May 15-17.

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The Fallible Man

ROBERT S. McNAMARA pointed his pencil at the man across the desk.

"What does the program definition study indicate?" he asked.

"The project is certain to succeed, Mr. McNamara," the man replied. "We have been studying it for five years. The design studies show that all phases of the program are within the state of the art. Cost effectiveness has been thoroughly analyzed. The computer studies show that we should meet the target date with no significant cost overruns. There is no question that this project meets all the required specifications. We recommend we go ahead with this one and that the alternative projects be cancelled."

"Splendid," said McNamara. "Cancel all the other cars; we'll just build the Edsel."

Secretary of Defense McNamara will be the first to assure you that no such conversation ever took place. If it had, the Ford Motor Co. today would be a financial shambles. Edsel was a dismal failure. Yet the project had been thoroughly analyzed by some of the finest minds in the automotive business and given the go-ahead by the management of one of the most successful firms in the industry. These experienced businessmen, operating in a familiar environment, were whipped by the unknowns.

Why do we bring up the Edsel?

Because we are certain that Mr. McNamara, if he had been Ford president at that time, never would have committed his company's future to a single design, no matter how well studied.

Yet, as Secretary of Defense, he apparently has no qualms about committing his nation's future to a single design concept.

As we study the philosophy of Defense Research and Engineering, we find men of high intelligence taking a highly unintelligent approach to the weapon systems which this nation will need in the future. They seem convinced that until it can be proven absolutely that a total system will work, until all question-marks are answered, until all risks are eliminated, no go-ahead should be given for development of a given project. Once committed to that philosophy of certainty, it is only a brief step to the belief that you need only one design. If you are so certain the first will work, why build two?

Show paper proposals to a scientist and he can assure you, after study, that one is more likely to succeed than another. Show them to an engineer and he'll tell you that the best way to find out is to build both of them and test them.

The dangers in our defense organization today lie in the fact that the heavily scientific organization of Defense Research and Engineering is making decisions that more practical engineers would decline to make without testing of hardware.

Today, as we have pointed out before, three-fourths of the new projects under study by the Joint Chiefs of Staff come down from DDR&E—a complete reversal of previous years when proposals flowed largely from the more practical minds of men in the military and industry.

We are told that the new single-design approach is necessary because weapon systems today are so costly that we cannot afford to embark on two parallel projects. We say the reverse is true: we cannot afford to abandon dual approaches—due to the simple fact that once wholly committed to the wrong road it becomes impossible to turn back because of the sheer size of the financial outlay already made. The cost of today's projects makes it imperative that dual approaches be explored before commitment to the entire weapons system.

Why not explore both *Gemini* and *Dyna-Soar* technology? Why not explore two TFX prototypes? No one can say now that one approach or another will be the successful one—paper studies just won't do the job.

There would be no problem, of course, if we had an infallible man as Secretary of Defense, one who could count on his advisers always to give him the correct advice and one who could always make the right decision.

LET'S TURN BACK the pages of recent aviation history and muse on what a single design approach might have done for the nation's well-being.

Turn back to the days just before World War II. Paper proposals for two fighter planes are being studied by Defense Research and Engineering.

"It is quite apparent," says a high Defense official, "that we don't need both these fighter aircraft. One will do. Cancel the P-38. We'll build only the P-39."

A few weeks later, more proposals are laid on his desk.

"Why should we go into two costly bomber programs?" he asks. "Cancel the B-17. We'll build only the B-24."

Months pass.

"Cancel the P-51," he says. "We'll build only the P-47."

We leave to those with more imagination the ruminations on what course World War II might have taken if we had been forced to fight it without the P-38, P-51 and B-17. The nation certainly might have saved a great deal of money and won the war quite handily, of course, if we had possessed a high Defense official who unerringly could have selected the P-38, P-51 and B-17 and cancelled the less successful alternatives. No such man existed then and none exists today.

We always will have with us the fallible man. The man who might cancel the F-86 in favor of the F-84 and never find out about his mistake until the Russian Migs swept down across the Yalu.

When it comes to military weapons, this nation cannot afford to guess. We must explore all alternative approaches to the furthest point in hardware that we possibly can afford. We must not let fallible man make irrevocable decisions.

We hope Mr. McNamara remembers the Edsel.

William J. Coughlin

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